MS-115

NEG.

project
**mercury**

OPERATION AND MAINTENANCE

# ACQUISITION SYSTEM KANO, NIGERIA-ZANZIBAR CANTON ISLAND

prepared for
National Aeronautics and Space Administration
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The Bendix Corporation
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in association with

WESTERN ELECTRIC COMPANY, INC.

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# SECTION I
# GENERAL DESCRIPTION

## 1-1. GENERAL INFORMATION

### A. SCOPE OF MANUAL

This publication comprises operating and service instructions for the acquisition system which forms a part of the Mercury ground instrumentation at the following sites: Kano, Nigeria; Zanzibar; and Canton Island.

### B. PROJECT MERCURY SCOPE

(1). The prime objective of Project Mercury is manned orbital flight with a safe return of the man from orbit. The manned vehicle or satellite that is placed into orbit is called the capsule, and the individual making the orbital flight is called the astronaut.

(2). A launch vehicle with a radio-inertial guidance system will be used to place the capsule into orbit. The launch will be from Cape Canaveral, Florida with launch azimuth slightly north of east (inclined 32.5 degrees to the equator) and nominal orbit insertion point approximately 410 nautical miles from Cape Canaveral. The planned orbit will have a period of 88 minutes and will be at an altitude of 105 ±5 nautical miles.

(3). Initially, the orbital flights will each consist of three orbital cycles with a water landing west of Puerto Rico. In the event of in-flight emergency, back-up systems are provided in the capsule to permit the flight to continue until the next passage over the eastern United States. Emergency landings at the completion of one orbit can be made in the Atlantic off of Charleston, South Carolina or near Bermuda. At the end of the second passage, the emergency landing area is in the Atlantic off of Charleston, South Carolina. If a malfunction occurs during the early launch phase, emergency procedures will permit a water landing off of Cape Canaveral. Controlled retro firing will be used to contain most of the abort impact areas near Bermuda or in the vicinity of the Canary Islands.

(4). To implement Project Mercury, a world-wide network of 18 ground-based tracking and instrumentation sites has been established together with a control center and a computing and communications center. Eleven of these sites are equipped with long range tracking radars; these compose the tracking network. Sixteen sites have telemetry receiving and display equipment. Six of the sites are equipped to transmit command control signals to the capsule; these are known as command sites. Sixteen of the sites are equipped with capsule communication equipment that provides two-way voice contact with the astronaut. In addition, all of the sites are linked with the computing and control centers by a ground communication network. See figure 1-1 for the locations of the sites.

C. SITE FUNCTIONS

From orbit insertion until landing, the tracking and ground instrumentation systems will provide continuous prediction of the capsule location, they will monitor the status of the capsule and astronaut, and they will permit the command functions necessary for the mission. The functions of the tracking and ground instrumentation systems are completed when the capsule has landed and the best possible information on the landing point location has been supplied to a recovery team. Table 1-I lists the various sites and the functions of each.

D. SYSTEM FUNCTION

The function of the acquisition system is to supply pointing data, that is, capsule azimuth and elevation, to the active acquisition aid, receiving antenna, and transmitting antenna. Pointing data is made available to the automatic-tracking active acquisition aid for initial acquisition of the capsule and to aid in quick re-acquisition if capsule tracking is lost during a pass over the site. During a pass, the receiving and transmitting antennas normally are pointed at all times by data from the acquisition system.

## 1-2. EQUIPMENT SUPPLIED

Table 1-II lists the equipment supplied for the acquisition system. A number of items of test equipment shown in this table are also used for other systems on the site. Such items are listed in the applicable manuals of the other systems as well as in this manual.

TABLE 1-I. FUNCTIONS OF EACH SITE

| | S-Band Radar Tracking | C-Band Radar Tracking | Telemetry & Capsule Communications | Command Control |
|---|---|---|---|---|
| Cape Canaveral, Fla. | X | X | X | X |
| Grand Bahama Island | — | — | X | — |
| Grand Turk Island | — | — | X | — |
| Bermuda | X | X | X | X |
| Atlantic Ship | — | — | X | — |
| Grand Canary Island | X | — | X | — |
| Kano, Nigeria | — | — | X | — |
| Zanzibar | — | — | X | — |
| Indian Ocean Ship | — | — | X | — |
| Muchea, Australia | X | — | X | X |
| Woomera, Australia | — | X | X | — |
| Canton Island | — | — | X | — |
| Kauai Island, Hawaii | X | X | X | X |
| Point Arguello, Calif. | X | X | X | X |
| Guaymas, Mexico | X | — | X | X |
| White Sands, New Mexico | — | X | — | — |
| Corpus Christi, Texas | X | — | X | — |
| Eglin, Florida | X | X | — | — |

TABLE 1-II. EQUIPMENT SUPPLIED

| Title | Manufacturer | Model | Qty. | Instruction Book Inventory Number and Title |
|---|---|---|---|---|
| OPERATING EQUIPMENT | | | | |
| Acquisition Data Console | Bendix Corporation Bendix Radio Division | R651498-4, -5, -6 | 1 | MS-115, Acquisition System Manual—Operation and Maintenance—Kano, Nigeria; Zanzibar; Canton Island. |
| Active Acquisition Aid, consisting of: | Cubic Corporation | — | 1 | ME-134, Instruction Manual for Simplified Acquisition Aid |
| Triplexer (Multiplexer) | — | — | 1 | — |
| Diplexer (Multiplexer) | — | — | 2 | — |
| RF Housing | — | — | 1 | — |
| Amplidyne | — | — | 2 | — |
| Receiver Cabinet | — | — | 1 | — |
| Servo Cabinet | — | — | 1 | — |
| Boresight Antenna & Transmitter | — | — | 1 | — |
| Antenna Pedestal, consisting of: | — | — | 1 | — |
| Quad-Helix Array | — | — | 1 | — |
| HF Dipole and Reflector | — | — | 1 | — |
| Ground Plane | — | — | 1 | — |
| Hybrid Ring | — | — | 4 | — |
| Pedestal | — | — | 1 | — |

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

| Title | Manufacturer | Model | Qty. | Instruction Book Inventory Number and Title |
|---|---|---|---|---|
| **OPERATING EQUIPMENT (Cont.)** | | | | |
| Synchro Reference Step-up Transformer | Bendix Corporation Bendix Radio Division | A665084-1 | 1 | MS-115, Acquisition System Manual—Operation and Maintenance—Kano, Nigeria; Zanzibar; Canton Island |
| Synchro Reference Step-down Transformer | Bendix Corporation Bendix Radio Division | A665085-1 | 2 | MS-115, Acquisition System Manual—Operation and Maintenance—Kano, Nigeria; Zanzibar; Canton Island |
| Antenna Drive Power Cutoff Switch and Warning Light | Bendix Corporation Bendix Radio Division | L653858 | 1 | MS-115, Acquisition System Manual—Operation and Maintenance—Kano, Nigeria; Zanzibar; Canton Island |
| Intercom Cabinet | Bendix Corporation Bendix Radio Division | N651474-1, -2 | 1 | MS-109, Intrasite PBX and Intercom System Manual |
| **TEST EQUIPMENT** | | | | |
| Oscilloscope | Hewlett-Packard Company Company | 130B | 1 | ME-200, Operating and Servicing Manual, Model 130B/BR Oscilloscope |
| Oscilloscope | Tektronix, Incorporated | 545A | 1 | ME-202, Instruction Manual, Type 535A, Type 545A, Cathode-Ray Oscilloscopes |
| Dual-Trace Calibrated Preamp | Tektronix, Incorporated | Type CA | 1 | ME-203, Instruction Manual, Type CA Plug-in Unit |
| Plug-in Preamplifier | Tektronix, Incorporated | Type L | 1 | ME-136, Instruction Manual, Type L Plug-in Unit |

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

| Title | Manufacturer | Model | Qty. | Instruction Book Inventory Number and Title |
|---|---|---|---|---|
| TEST EQUIPMENT (Cont.) | | | | |
| Viewing Hood | Tektronix, Incorporated | H510 | 1 | ME-202, Instruction Manual, Type 535A, Type 545A, Cathode Ray Oscilloscopes (Accessories Section) |
| Oscilloscope Cart | Technibilt Corporation | OC-2 (Bendix Radio Part—A683940-2) | 1 | — |
| Oscilloscope Cart | Technibilt Corporation | OC-2 (Bendix Radio Part—A683940-1) | 1 | — |
| Unit Regulated Power Supply | General Radio Company | 1201-B | 1 | ME-211, Operating Instructions, Type 1201-B Unit Regulated Power Supply |
| Regulated Power Supply | Lambda Electronics Company | 71 | 1 | ME-138, Instruction Manual, Lambda Regulated Power Supply Model 71 |
| DC Power Supply | John Fluke Manufacturing Company, Incorporated | 407 | 1 | ME-231, Model 407 DC Power Supply, Instruction Manual |
| Square Wave Generator | Tektronix, Incorporated | Type 105 | 1 | ME-230, Instruction Manual, Square Wave Generator Type 105 |
| Signal Generator | Boonton Radio Corporation | 225-A | 1 | ME-188, Instruction Manual for the Signal Generator Type 225-A |
| Sweep Generator | Telonic Industries, Incorporated | HN-3 | 1 | ME-120, Operating Instruction Manual |
| HF Signal Generator | Hewlett-Packard Company | 606-A | 1 | ME-189, Operating and Servicing Manual |
| Function Generator | Hewlett-Packard Company | 202-A | 1 | ME-205, Operating and Servicing Manual |

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

| Title | Manufacturer | Model | Qty. | Instruction Book Inventory Number and Title |
|---|---|---|---|---|
| TEST EQUIPMENT (Cont.) | | | | |
| Transfer Oscillator | Hewlett-Packard Company | 540-B | 1 | ME-232, Operating and Servicing Manual |
| Wide Range Oscillator | Hewlett-Packard Company | 200 CD | 2 | ME-198, Operating and Servicing Manual |
| Unit Oscillator | General Radio Company | 1209-BL | 1 | ME-212, Operating Instructions, Types 1209-B and BL Unit Oscillators |
| Universal EPUT and Timer | Beckman Instruments, Incorporated | 7370 | 1 | ME-196, Instruction Manual, Model 7370 Universal EPUT and Timer |
| Frequency Converter | Beckman Instruments, Incorporated | 7570 through 7573 | 1 | ME-197, Instruction Manual, Model 7570 Series Frequency Conversion Equipment |
| Field Strength Meter | Empire Devices Products Corporation | NF-105 (Bendix Part No. A683351) | 1 | ME-192, Instruction Manual for Noise and Field Intensity Meter |
| Power Output Meter | The Daven Company | OP-962 | 1 | ME-154, Instruction Manual |
| Potentiometric DC Voltmeter | John Fluke Manufacturing Company, Incorporated | 801 | 1 | ME-118, Model 801 Potentiometric DC Voltmeter, Instruction Manual |
| Vacuum Tube Voltmeter | Hewlett-Packard Company | 410B | 2 | ME-190, Operating and Servicing Manual |
| Vacuum Tube Voltmeter | Hewlett-Packard Company | 400D | 2 | ME-191, 400D/H/L Vacuum Tube Voltmeter Operating and Servicing Manual |
| Volt-Ohm-Milliammeter | Triplett Electrical Instrument Company | 630-PL | 3 | ME-193, Instruction Manual, Model 630-PL Volt-Ohm-Milliammeter |

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

| Title | Manufacturer | Model | Qty. | Instruction Book Inventory Number and Title |
|---|---|---|---|---|
| TEST EQUIPMENT (Cont.) | | | | |
| Noise and Distortion Analyzer | Hewlett-Packard Company | 330B | 1 | ME-194, 330B/C/D Noise and Distortion Analyzer, Operating and Servicing Manual |
| RF Detector | Telonic Industries, Incorporated | XD-3 | 2 | ME-135, Instruction Manual |
| Tube Analyzer | Triplett Electrical Instrument Company | 3444 | 1 | ME-199, Instruction Manual, Model 3444 Tube Analyzer |
| Variac | General Radio Company | W10MT | 1 | ME-246, Operating Instructions for W10 Variac |
| Attenuator Pad | Telonic Industries Incorporated | TGC-50 | 2 | — |
| Miscellaneous Cables and Accessories | — | — | — | — |

## 1-3. DESCRIPTION OF ACQUISITION SYSTEM

### A. GENERAL

(1). The major components of the acquisition systems at Kano, Zanzibar, and Canton are an acquisition data console and an active acquisition aid. Each of these units is described in the following paragraphs.

(2). Additional equipment in the systems includes synchro reference voltage step-up and step-down transformers and an antenna drive power cutoff switch and warning light.

### B. PHYSICAL DESCRIPTION

The following paragraphs give a physical description of the equipment at each of the three sites.

#### (1). ACQUISITION DATA CONSOLE (Figure 1-2)

The acquisition data console consists of a rack, 59-5/8 inches high, 23-9/16 inches wide, and 22 inches deep, on which are mounted several panels. As shown in figure 1-2, it is bolted to the active acquisition aid receiver cabinet and servo cabinet. A writing surface extends 18-1/2 inches from the front of the console Omitting blanks and starting from the top, the panels on the acquisition data console are an acquisition data panel (number 1), a signal strength meter panel, another acquisition data panel (number 2), and audio amplifier, and a dual power supply. On top of the acquisition data console, mounted in a separate cabinet, is an intercom panel. A relay chassis is mounted inside the console on the right side near acquisition data panel number 2. A synchro reference voltage step-down transformer is mounted inside and to the rear of the console. The intercom panel is not functionally a part of the acquisition data console. For information on it, refer to the Intrasite PBX and Intercom System Manual, MS-109.

##### (a). ACQUISITION DATA PANEL NUMBER 1

1. Across the top of the panel there are three pairs of synchro receivers which display azimuth and elevation data from the active acquisition aid, the receiving antenna, and the transmitting antenna. There also are three pairs of lamps which indicate the azimuth position of the active acquisition aid,receiving, and transmitting antennas relative to the limits of cable wrap.

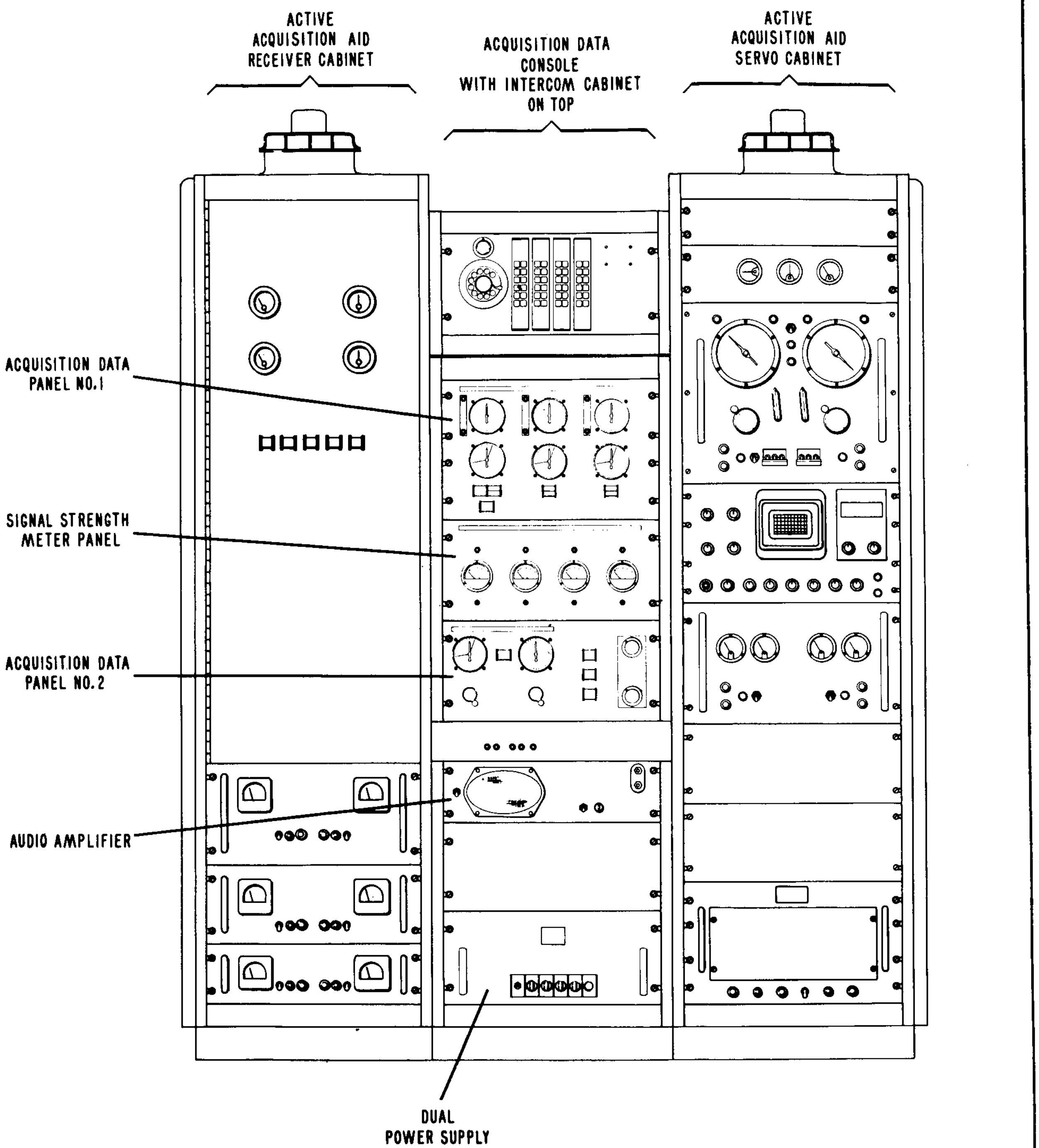



Figure 1-2. Acquisition Data Console, Intercom Cabinet, and Active Acquisition Aid Receiver Cabinet and Servo Cabinet

2. Just below the synchro receivers there is a row of indicator and switch assemblies, henceforth called simply indicators and switches. The indicators consist of a set of lamps, color filters over the lamps, and a white, translucent screen on the front of the assembly. The switches are like the indicators with the addition of a multi-pole switch and a coil which, when energized, holds the switch contacts in their actuated position. The switch is initially actuated by depressing the screen. The screens of both the indicators and switches always appear white when the lamps are not lit. When the lamps are lit, the screens appear red, yellow, or green, depending on the color of the filters in the particular assembly.

3. On the left, below the active acquisition aid synchro receivers, are two indicators and one switch. One of the indicators is labeled "AUTO" (yellow when lit). The other is a double indicator, the top half of which is labeled "SLAVED" (green when lit), and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

4. Beneath the receiving antenna synchro receivers there is one double indicator. The top half is labeled "SLAVED" (green when lit), the bottom half is labeled "MANUAL" (red when lit).

5. Beneath the transmitting antenna synchro receivers there is one double indicator. The top half is labeled "SLAVED" (green when lit), and the bottom half "MANUAL" (red when lit).

(b). <u>ACQUISITION DATA PANEL NUMBER 2</u>

1. In the top center and top left-hand corner of acquisition data panel number 2, there is a pair of synchro transmitter-synchro receiver combinations, one for manual elevation settings and one for manual azimuth settings. The synchro transmitters are turned by handwheels on the front of the panel. The synchro receivers indicate the angular position of the transmitter rotors. Between the two receivers there is a switch labeled "SOURCE" (yellow when lit).

2. To the right of the synchro transmitter-receiver combinations there is one indicator and two switches. The indicator is labeled "NO DATA ON BUS" and is red when lit. Both of the switches are labeled "28 V SUPPLY" and are either red or green when lit.

(c). SIGNAL STRENGTH METER PANEL

Across the center of the signal strength meter panel are four signal strength meters which show the strength of the signal at the telemetry receivers at the site. Below each of the meters is a pilot lamp which correlates monitored telemetry audio with the metered signal strength.

(d). DUAL POWER SUPPLY

The dual power supply panel provides mounting for four chassis. These chassis, together with the relay chassis described below, make up two 28 VDC power supplies. Each power supply has a transformer, a silicon bridge rectifier, a fuse, and two filter capacitors on one chassis and a filter choke and three filter capacitors on a second chassis. On the front of the panel are an off-on switch, which controls the primary power to both power supplies; a power-on indicator; and four line fuses — two for each power supply — in indicating-type fuse holders.

(e). AUDIO AMPLIFIER

The audio amplifier consists primarily of a power supply, two vacuum tube voltage amplifier stages, and an output stage. On the front panel of the amplifier there is a speaker, a speaker off-on switch, a power off-on switch, a fuse, and a pair of phone jacks.

(f). RELAY CHASSIS

The relay chassis or the console provides mounting for two relays and two Zener diodes, which make up control circuitry for the 28 VDC power supplies. It also provides mounting for three relays which, when energized, connect acquisition data from various sources to the acquisition bus.

(2). ACTIVE ACQUISITION AID (Figures 1-2 through 1-8)

The active acquisition aid, which is a system in itself, comprises ten major units or assemblies; a receiver cabinet, a servo cabinet, an antenna and pedestal, two amplidynes, two diplexers, a triplexer, and RF housing, and a boresight antenna and transmitter.

(a). The receiver cabinet contains the circuits of the active acquisition aid which develop the error signals used to position the antenna for tracking. The receiver cabinet is 23-9/16 inches wide, 22 inches deep, and 77 inches high. It is bolted to the acquisition data console. (See figure 1-2.)

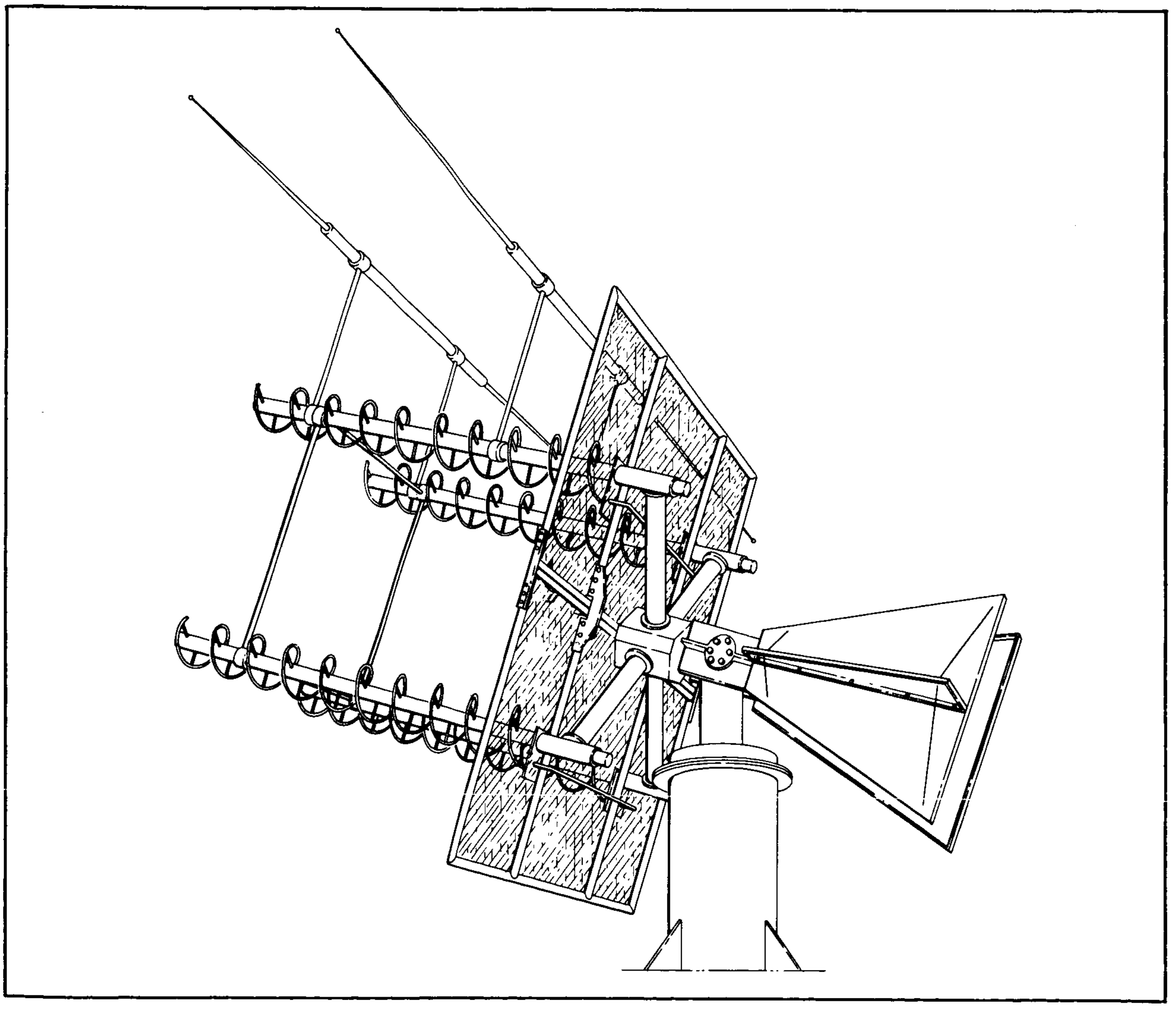


Figure 1-3. Active Acquisition Aid Antenna and Pedestal

(b). The servo cabinet (figure 1-2) houses components of the servo system which positions the antenna in azimuth and elevation. Its overall physical dimensions are the same as those of the receiver cabinet and like the receiver cabinet, is bolted to the acquisition data console.

(c). The active acquisition aid antenna and pedestal (figure 1-3) includes a quad-helix array, an HF dipole and reflector, a ground plane, four hybrid rings, and the pedestal itself.

(d). For physical descriptions of the amplidynes, diplexer, triplexer, RF housing, and boresight antenna and transmitter (figures 1-4 through 1-8) and for complete physical descriptions of the control console, receiver cabinet, servo cabinet, and antenna and pedestal, refer to the applicable equipment manual.

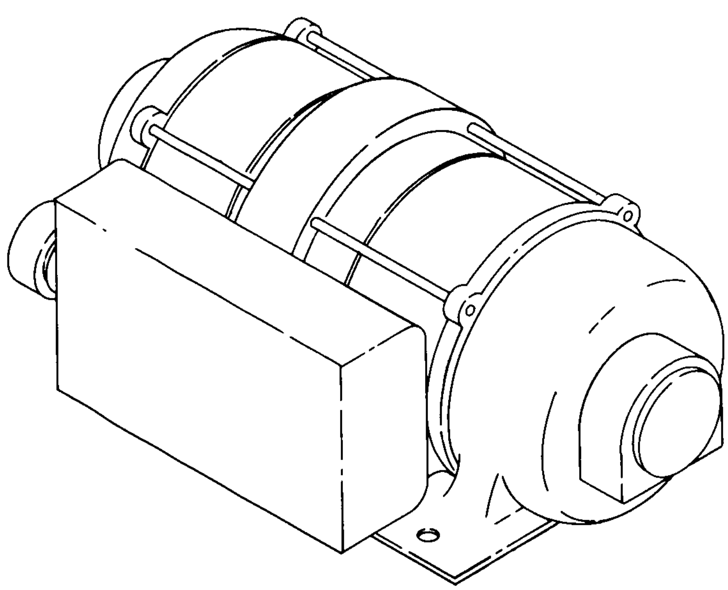


Figure 1-4. Active Acquisition Aid Amplidyne

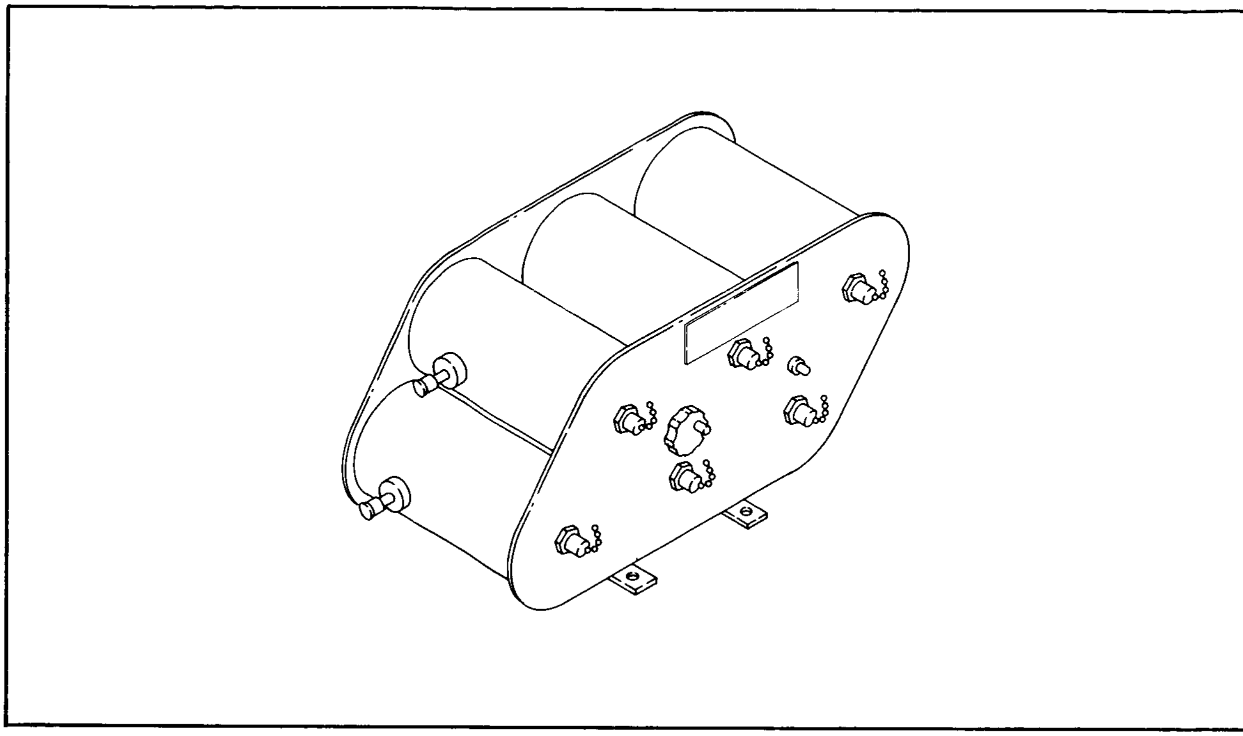


Figure 1-5. Active Acquisition Aid Diplexer (Multiplexer)

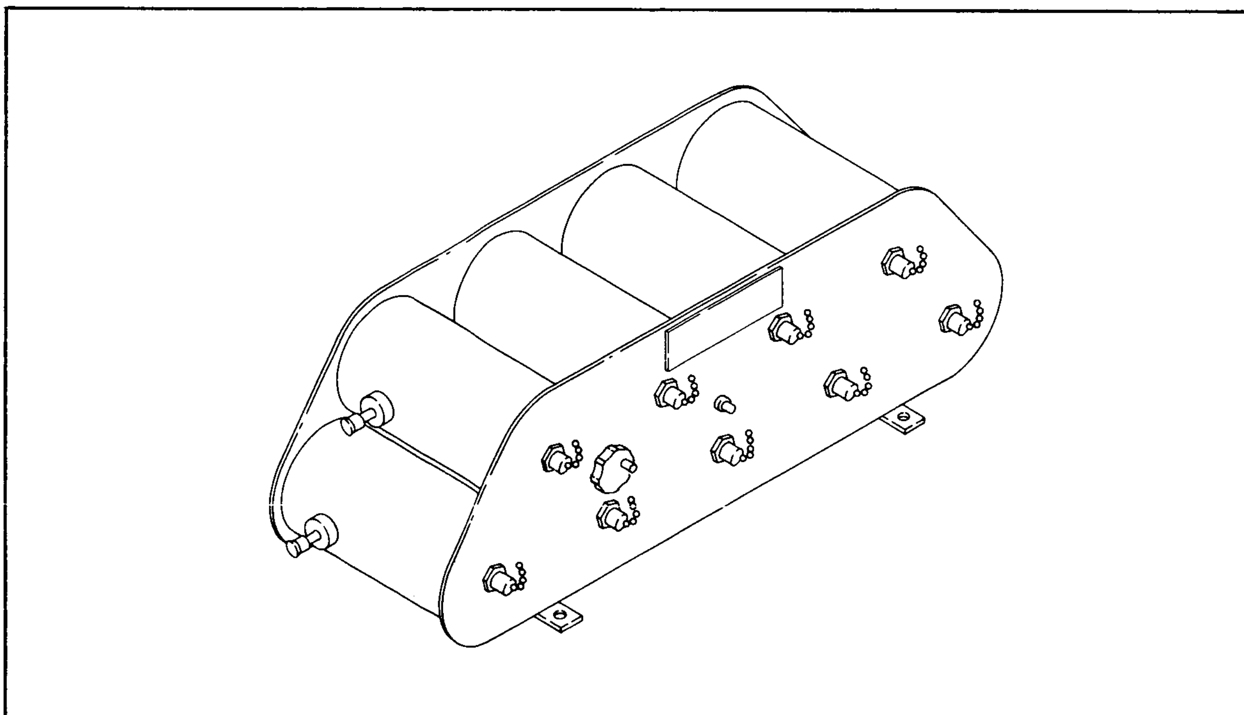


Figure 1-6. Active Acquisition Aid Triplexer (Multiplexer)

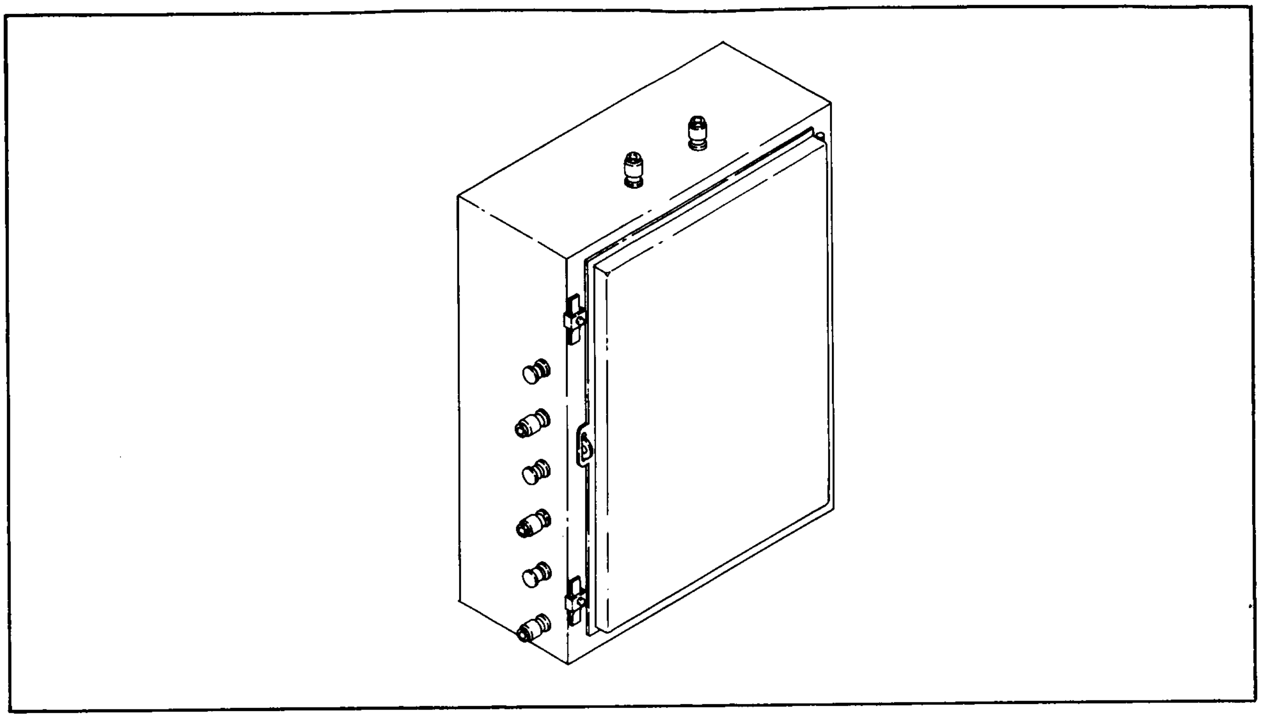


Figure 1-7. Active Acquisition Aid RF Housing

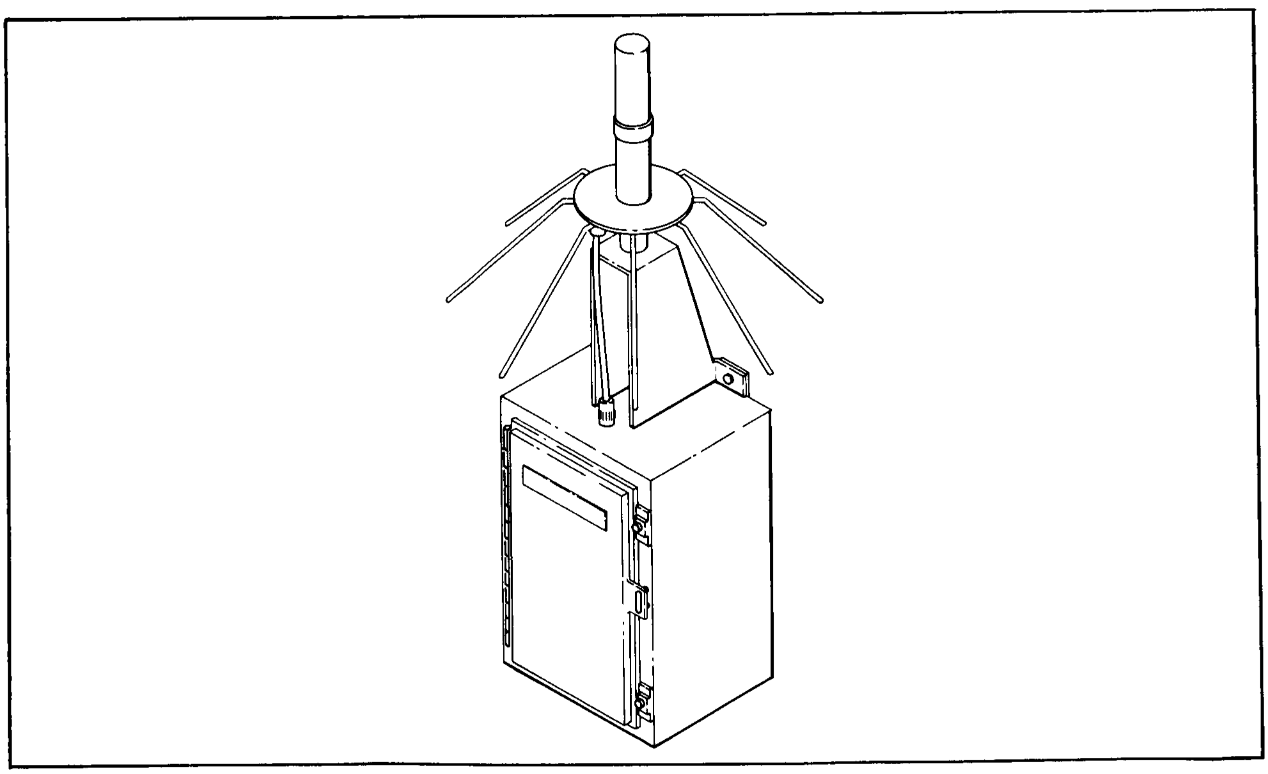


Figure 1-8. Active Acquisition Aid Boresight Antenna and Transmitter

(3). ADDITIONAL EQUIPMENT

(a). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

The synchro reference voltage step-up transformer is shown in figure 1-9. Its dimensions are 12-1/2 inches by 13 inches by 15 inches, and its weight is 150 pounds. The synchro reference voltage step-down transformer is also shown in figure 1-9. Its dimensions are 7-5/8 inches by 7-5/8 inches by 7-1/2 inches, and its weight is 35 pounds.

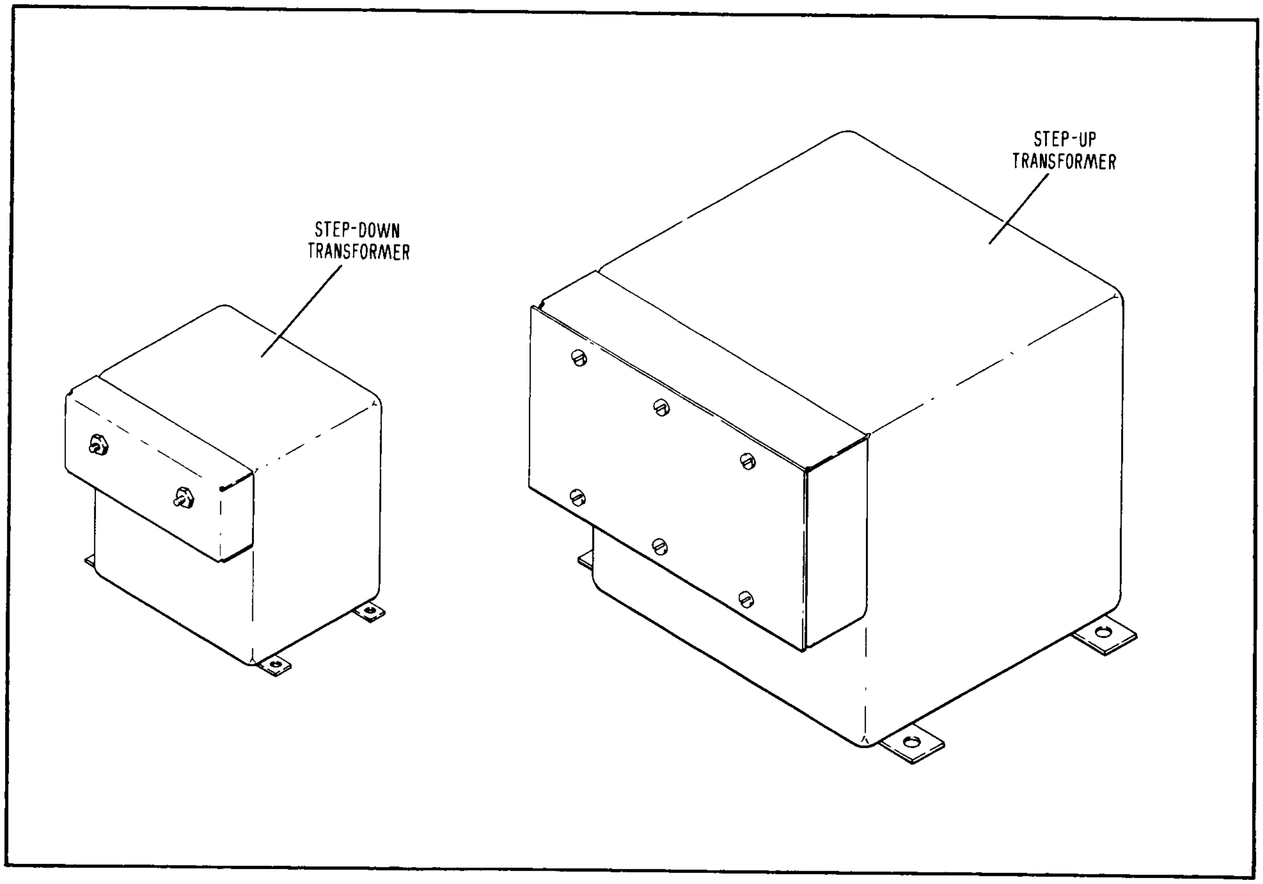



Figure 1-9. Synchro Reference Voltage Step-up and Step-down Transformers

(b). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light (figure 1-10) contains a double-pole, single-throw switch and a red warning light mounted on a 6-inch by 12-3/4-inch frame.

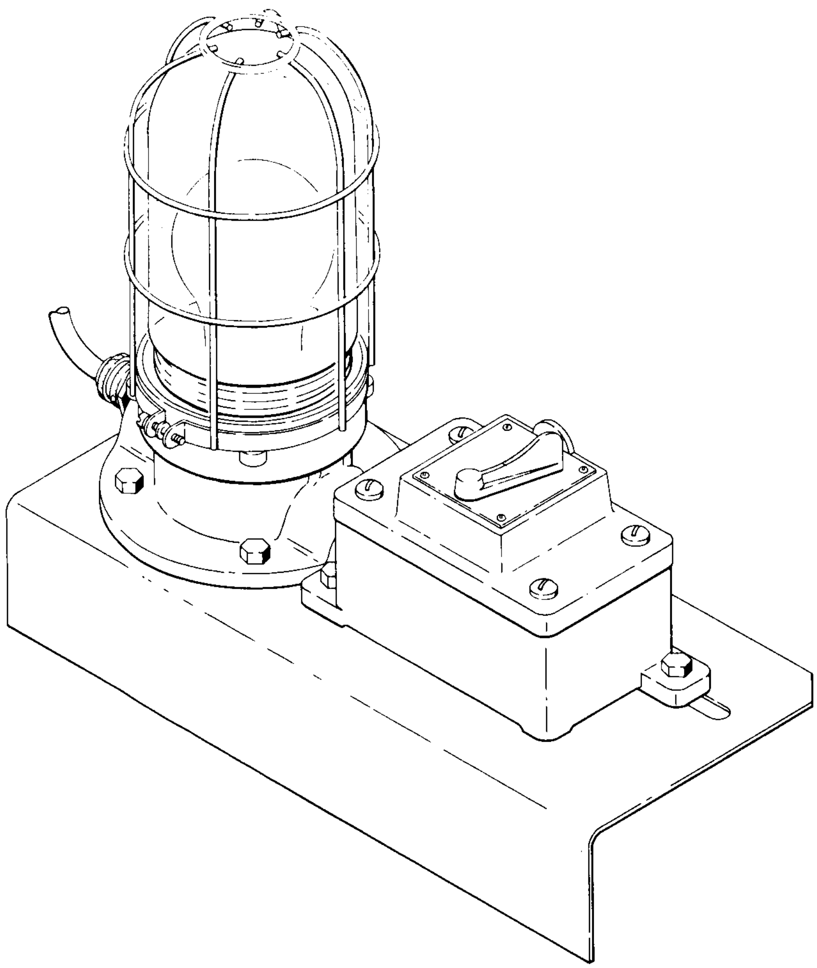


Figure 1-10. Antenna Drive Power Cutoff Switch and Warning Light

C. FUNCTIONAL DESCRIPTION

(1). GENERAL

The following paragraphs describe the major components in the acquisition system.

(a). The acquisition system at each of the three sites is made up primarily of an acquisition data console and an active acquisition aid.

(b). The function of the acquisition system is to supply the best data available on the azimuth and elevation of the capsule to steerable antennas on the site. Figure 1-11 illustrates this function. When no actual tracking information is available, predicted azimuth and elevation of the capsule at a given time are put onto the acquisition bus by the setting of synchro transmitters on the acquisition data console. The setting of these synchro transmitters is the manual input shown in figure 1-11. The information manually set in at the acquisition data console is then available to the active acquisition aid, the receiving

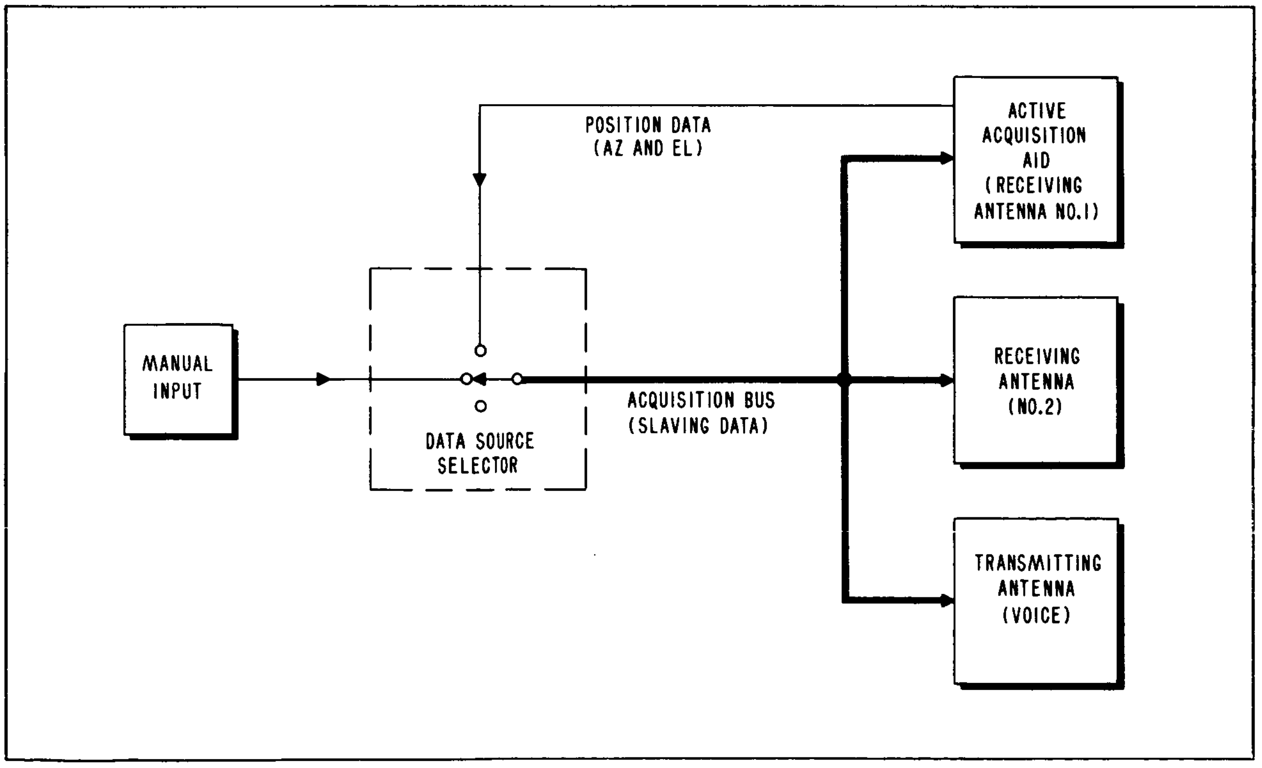



Figure 1-11. Acquisition System, Simplified Block Diagram

antenna, and the transmitting antenna. Once the active acquisition aid has acquired and is tracking the capsule automatically or manually, its information on capsule azimuth and elevation is available for putting on the acquisition bus for use by all of the other steerable antennas on the site.

(c). Figure 1-11 is a simplified block diagram of the acquisition system at the three sites. The acquisition bus, which distributed two channels (azimuth and elevation) of acquisition data, is illustrated by heavy lines. Data from one of two sources, manual input or the active acquisition aid, is put onto the acquisition bus by the data source selector, which consists of several switches and relays on the acquisition data console. From the data source selector, the bus goes to the active acquisition aid, to the receiving antenna, and to the transmitting antenna. Manual data is available for switching onto the acquisition bus whenever the synchro transmitters on the acquisition data console have the necessary information set into them. Data from the active acquisition aid can be switched onto the bus whenever it is tracking automatically or manually. In addition to the position data from the active acquisition aid, display data and operating mode information from the active acquisition aid, the transmitting antenna, and the receiving antenna are supplied to the acquisition data console. The paths of the display data and operating mode information are not shown on figure 1-11.

(2). ACQUISITION DATA CONSOLE

The acquisition data console is the control center of the acquisition system. It contains indicator lights, synchro displays (receivers), and control switches. It also contains synchro transmitters for putting predicted acquisition data into the system. The inputs to the console, other than primary power, are operating mode information in d-c form, synchro display data, and synchro position data. The operating mode information is used simply to light lamps which indicate the operating mode of the steerable antennas: automatic tracking, manual tracking, or slaved. Synchro position data is put on the acquisition bus for slaving the active acquisition aid, the transmitting antenna, and the receiving antenna. Synchro display data is displayed by means of synchro receivers on the console. This data is used only for monitoring purposes; it is not put on the acquisition bus for slaving purposes. The functions of the various indicators, displays, and controls on the console are described in the following paragraphs; a simplified schematic is shown in figure 1-12.

(a). The d-c indications coming into the console from the transmitting antenna are "SLAVED" and "MANUAL" mode indications and a "CABLE WRAP" indication. The only synchro data from the transmitting antenna is azimuth and elevation display data. This data is displayed on two synchro receivers on the console. (Each of the synchro symbols on figure 1-12 represents a pair of synchros, one for azimuth data and one for elevation data.) The mode indicators (which are controlled by an operator at the transmitting antenna servo rack) and the synchro displays allow the acquisition data console operator to monitor the operation of the transmitting antenna insofar as its positioning in azimuth and elevation is concerned. The cable wrap indication permits the acquisition data console operator to determine the azimuth position of the transmitting antenna relative to its cable wrap limits. (The rotation of the transmitting antenna is restricted to 540 degrees because of cabling which wraps around the pedestal as it turns.)

(b). The d-c indications and synchro data coming into the acquisition data console from the receiving antenna are the same as those coming from the transmitting antenna (described in the paragraph above).

(c). The d-c indications coming linto the acquisition data console from the active acquisition aid are "AUTO", "SLAVED", and "MANUAL" mode indications and a "CABLE WRAP" indication. These indications show whether the active acquisition aid is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The cable wrap indication is the same as that from the transmitting and receiving antennas. Two separate sets of synchro information come into the console from the active acquisition aid; these are display data and position data. The display data is displayed on a pair of synchro receivers on the console. The position data, which comes from a separate pair of synchro transmitters on the active acquisition aid, is available for switching onto the acquisition bus.

(d). Data from the manual input synchro transmitters on the console is displayed by a pair of synchro receivers and is available for switching onto the acquisition bus.

(e). Indications of the strength of the r-f signals received by the site's four telemetry receivers come into the console from the telemetry equipment and are shown by signal strength meters, one for each of the indications. (Two of the telemetry receivers are connected to the active acquisition aid antenna, and the other two to the receiving antenna.) Audio signals are received from the site telemetry equipment and the active acquisition aid. The audio signals, one of which is selected by the audio channel selector switch, are used by the acquisition data console operator to confirm that the signal strength indications are actually telemetry audio and not just noise. (The paths of the signal strength indications and audio signals are not shown on figure 1-12.)

(f). There are two 28 VDC power supplies on the acquisition data console, either one of which is capable of supplying all of the power needed to operate the console indicators and controls. Two power supplies are used to increase the reliability of the equipment, and provision is made to disconnect a power supply automatically when its voltage drops below a certain level. The circuitry which performs this action is shown in simplified form on figure 1-12. Across the output of each of the power supplies there is a control relay whose contacts apply 28 VDC to either a red or green lamp in the "power supply on-failure indicator." When both power supplies are on and functioning properly, both of the control relays are energized and the green lamps are lit in both indicators. Then, if the voltage output of one power supply drops below a certain value, the control relay associated with that power supply is de-energized and the red lamp in the indicator for that power supply is lit. De-energizing the control relay

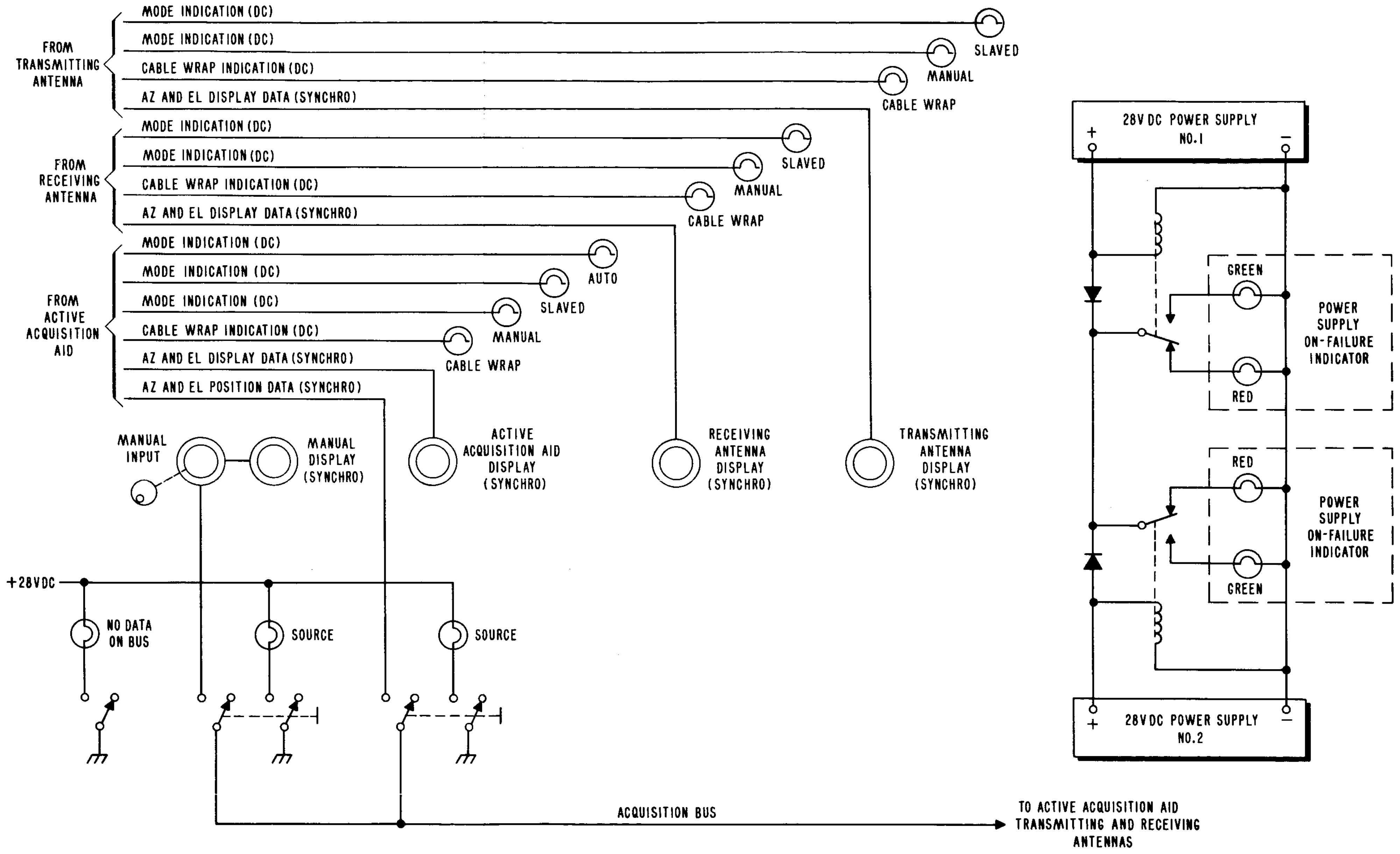



Figure 1-12. Acquisition Data Console, Simplified Schematic Diagram

also causes primary power to be removed from the malfunctioning power supply. (The red indicator lamp is supplied with power from the other, normally-operating power supply.) Note that when one power supply has been turned on and the other has not, a failed indication (red light) is given for the power supply not turned on; the control circuit gives the same indication for a condition of one power supply turned on and one off as it does for both turned on and one malfunctioning.

(3). ACTIVE ACQUISITION AID

(a). The active acquisition aid is an automatic angle-tracking device which provides acquisition data to the acquisition system for use by the other antennas on the site. It tracks the capsule in azimuth and elevation (but not in range) by means of the telemetry signals transmitted from the capsule, and puts out azimuth and elevation position and display synchro data. (The active acquisition aid antenna is also used for telemetry and HF and UHF voice communications reception; refer to the applicable system manuals.)

(b). In addition to supplying data to the acquisition system, the active acquisition aid can be slaved (positioned in accordance with externally supplied azimuth and elevation data) to data from the manual inputs on the acquisition data console.

(c). The salient characteristics of the active acquisition aid are as follows:

Operating modes: automatic, slaved, manual

Operating frequency: either one of any two, preset frequencies in the range 225 to 260 MC

Tracking accuracy (at 10 per second tracking rate):

Azimuth: 0.5°

Elevation: 0.5° at angles greater than 15°
1.0° at angles between 10° and 15°

Antenna:

Type of array: Quad helix

Polarization: circular, right-hand sense

Antenna: (cont.)

Elevation limits: minus 10° to plus 110°

Azimuth limit: 540°

Beamwidth: 20° at 3-db points

(d). For a complete functional description of the active acquisition aid, refer to the applicable equipment manual, listed in table 1-II.

(4). ADDITIONAL EQUIPMENT

(a). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

The synchro reference voltage step-up transformer and step-down transformers are provided to reduce the amount of current transmitted over considerable distances. (See Section II for the location of the transformers.)

(b). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

An antenna drive power cutoff switch and warning light is mounted on the active acquisition aid antenna tower. When open, it disconnects antenna drive motor power. The warning light is lit whenever the switch is closed. (See Section II for the location of the cutoff switch and warning light.)

1-4. SITE IMPLEMENTATION

A. GENERAL

(1). The following paragraphs deal with the allocation, location, and housing of equipment for the acquisition system at each of the three sites covered by this manual.

(2). The nomenclature used in this manual for the antennas which are part of or are connected to the acquisition system differs slightly from the nomenclature used in the capsule communications and command control transmitting system manuals. For cross reference purposes the two sets of nomenclature are listed below:

| ACQUISITION SYSTEM NOMENCLATURE | CAPSULE COMMUNICATIONS SYSTEM NOMENCLATURE |
| --- | --- |
| Active Acquisition Aid Antenna | Receiving Antenna No. 1 |
| Receiving Antenna | Receiving Antenna No. 2 |
| Transmitting Antenna | Voice Transmitting Antenna |

B. KANO, NIGERIA

(1). EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at the Kano, Nigeria site is listed in table 1-II.

(2). SITE DESCRIPTION

(a). SITE LAYOUT

Acquisition equipment at Kano is in the telemetry and control building on the active acquisition aid antenna tower, and on a bore-sight tower. See figure 1-13. The active acquisition aid antenna is west of the telemetry and control building, and the boresight tower is east of the telemetry and control building.

(b). EQUIPMENT LOCATION

1. ACQUISITION DATA CONSOLE

The acquisition data console is in the telemetry and control building in the location shown on figure 1-14.

2. ACTIVE ACQUISITION AID

The active acquisition aid receiver and servo cabinets are next to the acquisition data console as shown in figure 1-14. The amplidynes are just outside the front of the telemetry and control building. The diplexers, triplexer, and RF housing are mounted on the antenna tower (figure 2-4). The boresight antenna is on the boresight tower, and the boresight transmitter is at the base of the boresight tower (figure 2-5).

3. RECEIVING ANTENNA

The receiving antenna, which is not a part of the acquisition system but is connected to it, is in front of the telemetry and control building at the north end of the building (see figure 1-13).

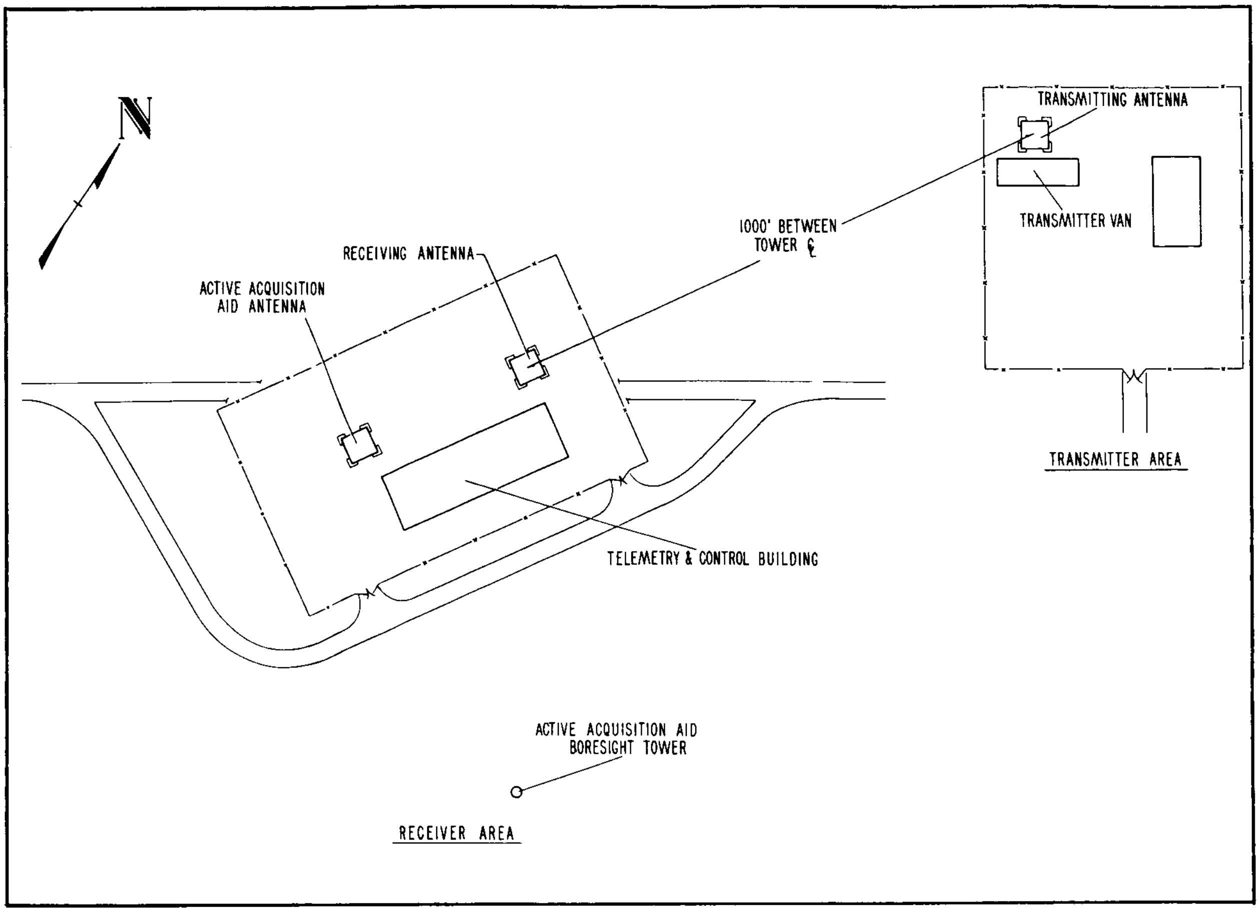



Figure 1-13. Site Layout, Kano, Nigeria

4. TRANSMITTING ANTENNA

The transmitting antenna, like the receiving antenna, is not a part of the acquisition system but is connected to it. It is on the tower on the hardstand near the three-unit generator building (see figure 1-13). As shown in figure 1-19, the transmitting antenna servo rack is in the transmitting van.

C. ZANZIBAR

(1). EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at the Zanzibar site is listed in table 1-II.

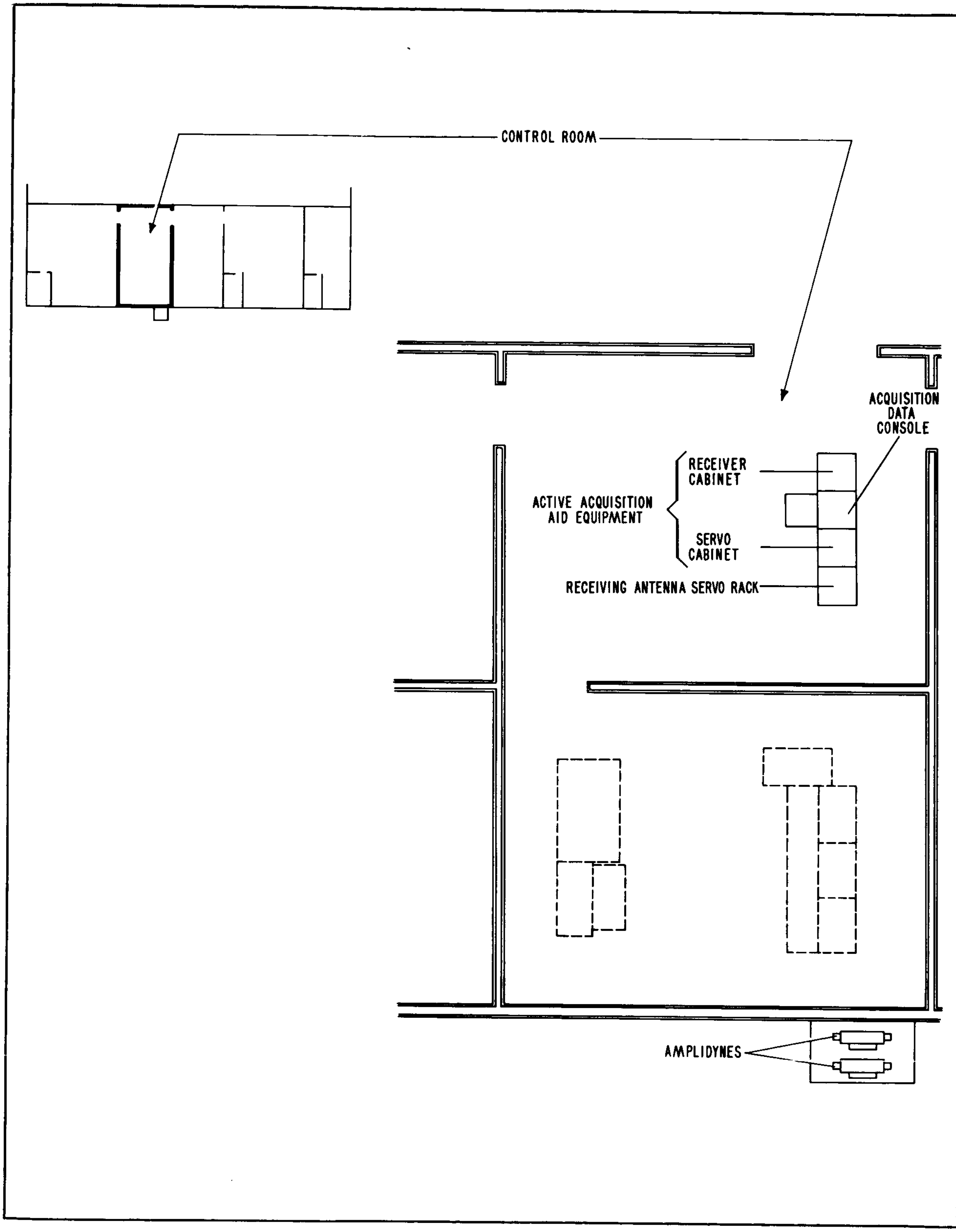



Figure 1-14. Acquisition System Equipment Layout, Telemetry and Control Building, Kano, Nigeria

(2). SITE DESCRIPTION

(a). SITE LAYOUT

Acquisition system equipment at Zanzibar is in the telemetry and control building, on the active acquisition aid antenna tower (just off the south corner of the telemetry and control building), and on a boresight tower southeast of the telemetry and control building (see figure 1-15).

(b). EQUIPMENT LOCATION

1. ACQUISITION DATA CONSOLE

The acquisition data console is in the telemetry and control building in the location shown in figure 1-16.

2. ACTIVE ACQUISITION AID

The active acquisition aid receiver and servo cabinets are next to the acquisition data console as shown in figure 1-16. The amplidynes are just outside the front of the telemetry and control building. The diplexers, triplexers, and RF housing are mounted on the antenna tower (figure 2-4). The active acquisition aid boresight antenna is on the boresight tower, and the boresight transmitter is at the base of the boresight tower (figure 2-5).

3. RECEIVING ANTENNA

The receiving antenna, while not a part of the acquisition system but connected to it, is east of the telemetry and control building, just off the northern end of the building. (See figure 1-15.)

4. TRANSMITTING ANTENNA

The transmitting antenna, like the receiving antenna, is not a part of the acquisition system but is connected to it. It is located near the three-unit generator building northeast of the telemetry and control building (see figure 1-15). The transmitting antenna servo rack is in the transmitting van (figure 1-19).

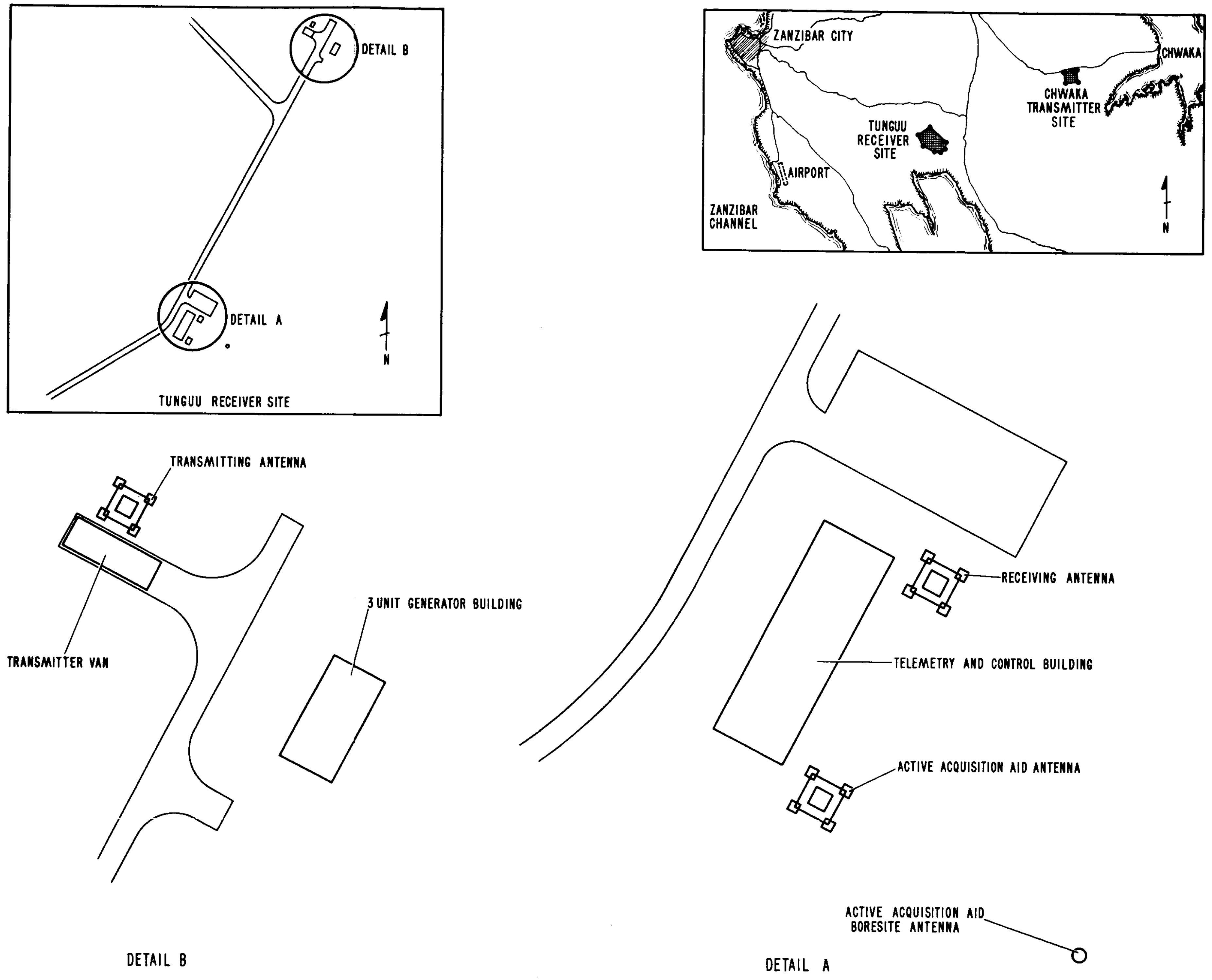



Figure 1-15. Site Layout, Zanzibar

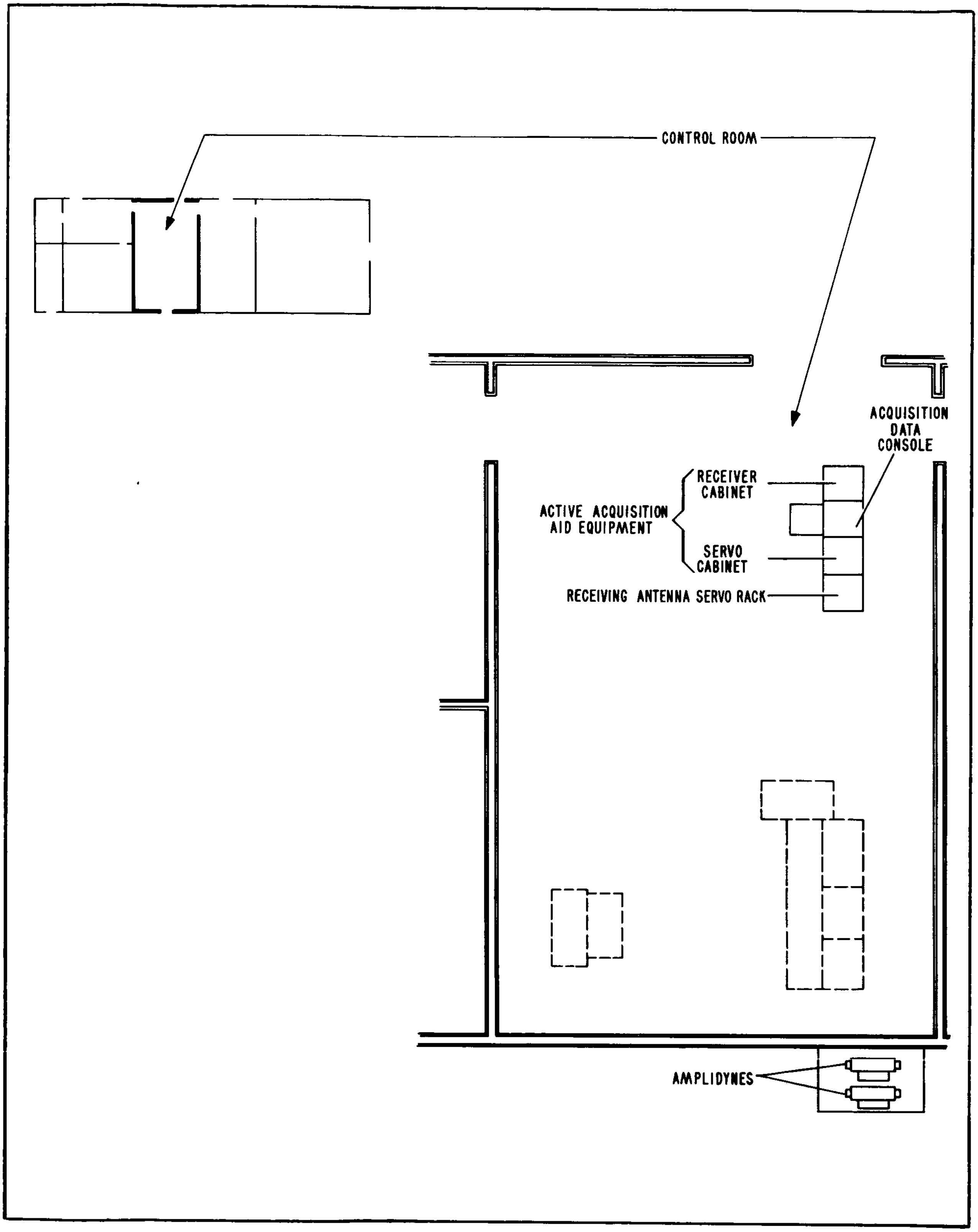



Figure 1-16. Acquisition System Equipment Layout, Telemetry and Control Building, Zanzibar

D. CANTON ISLAND

(1). EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at Canton Island is listed in table 1-II.

(2). SITE DESCRIPTION

(a). SITE LAYOUT

The acquisition system equipment at Canton is in the telemetry and control building, on the active acquisition aid antenna tower (just off the north corner of the telemetry and control building) and on a boresight tower (east of the telemetry and control building). (See figure 1-17.)

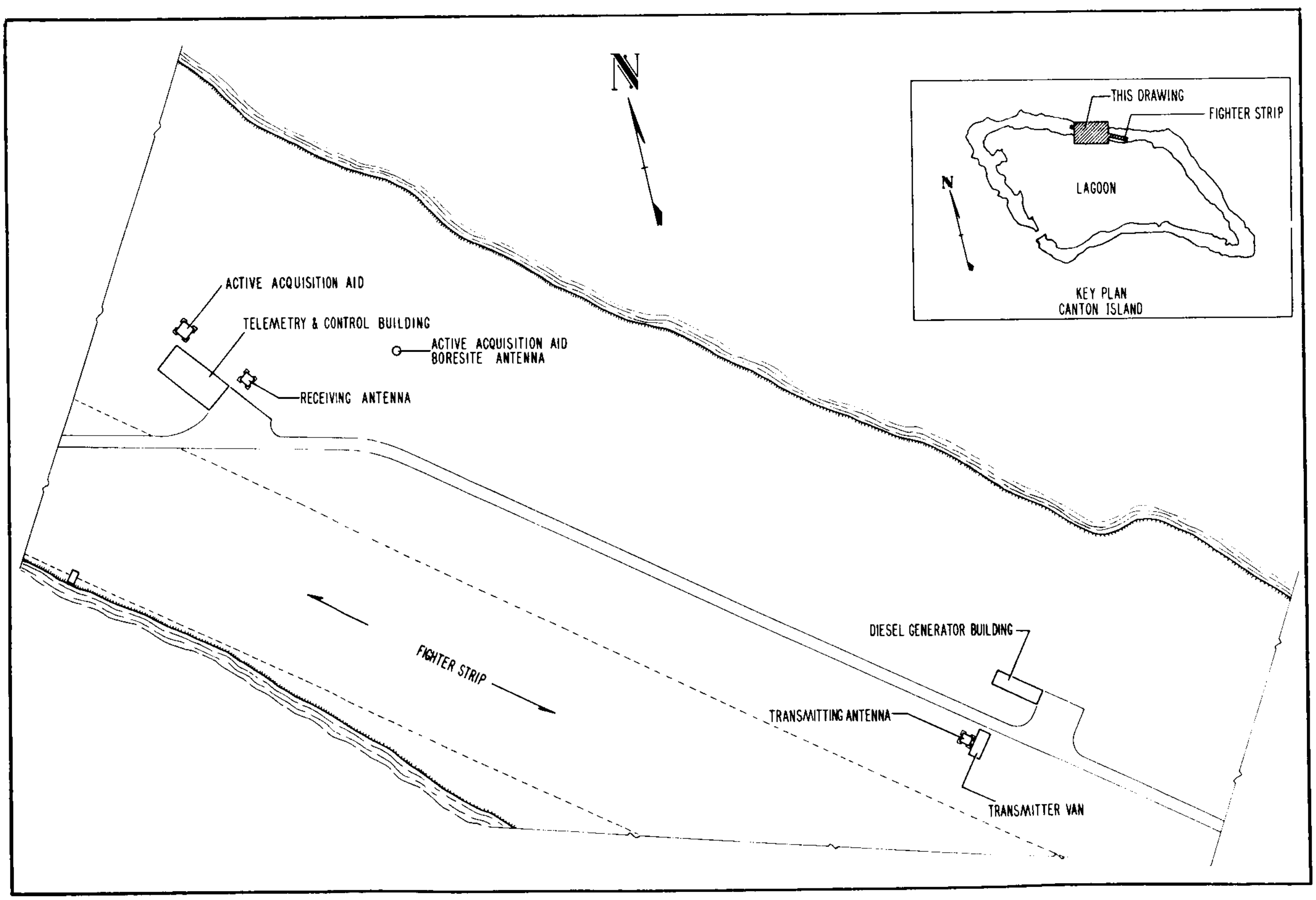



Figure 1-17. Site Layout, Canton Island

(b). EQUIPMENT LOCATION

1. ACQUISITION DATA CONSOLE

The acquisition data console is in the telemetry and control building in the location shown in figure 1-18.

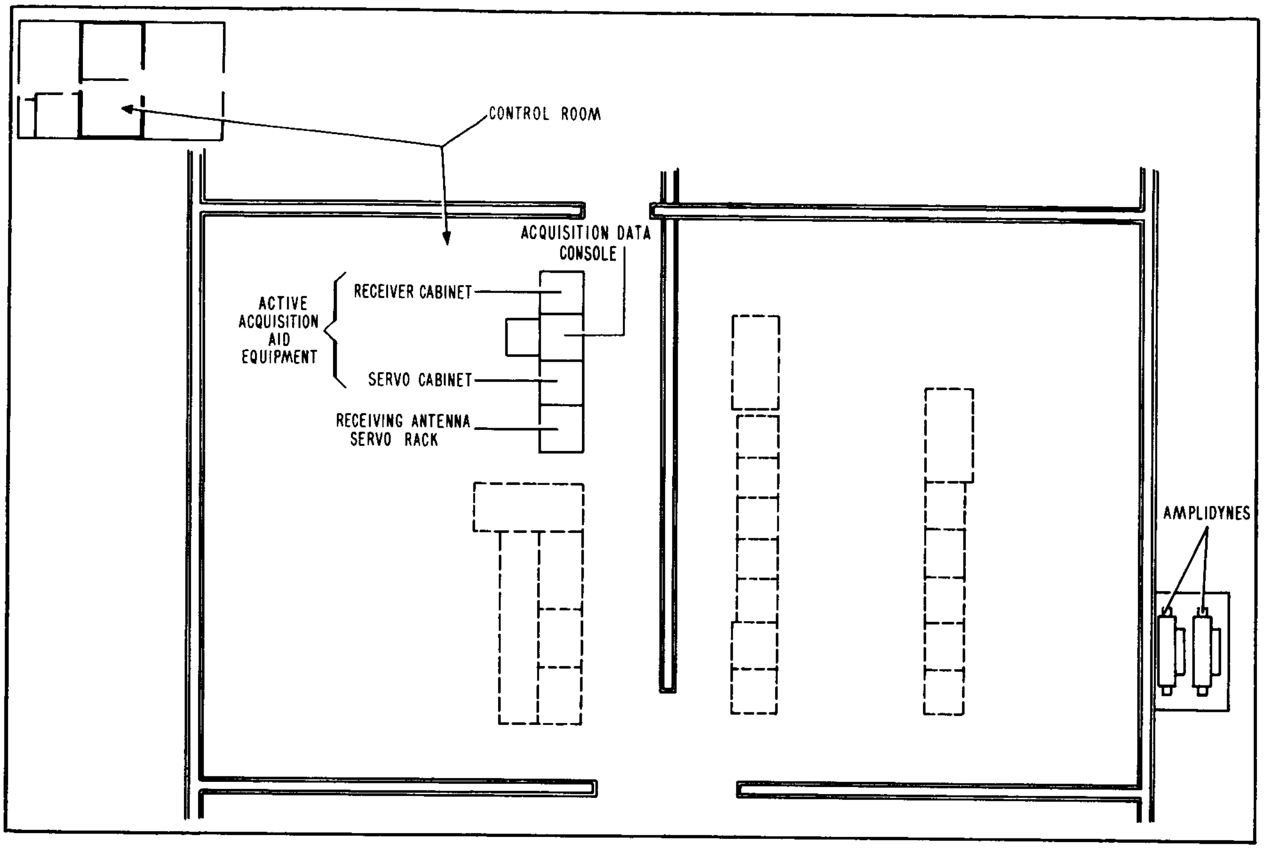



Figure 1-18. Acquisition System Equipment Layout, Telemetry and Control Building, Canton Island

2. ACTIVE ACQUISITION AID

The active acquisition aid receiver and servo cabinets are next to the acquisition data console as shown in figure 1-18. The amplidynes are just outside the front of the building. The diplexers, triplexers, and RF housing are mounted under the antenna pedestal (figure 2-4). The boresight antenna is on the boresight tower, and the boresight transmitter is at the base of the boresight tower (figure 2-5).

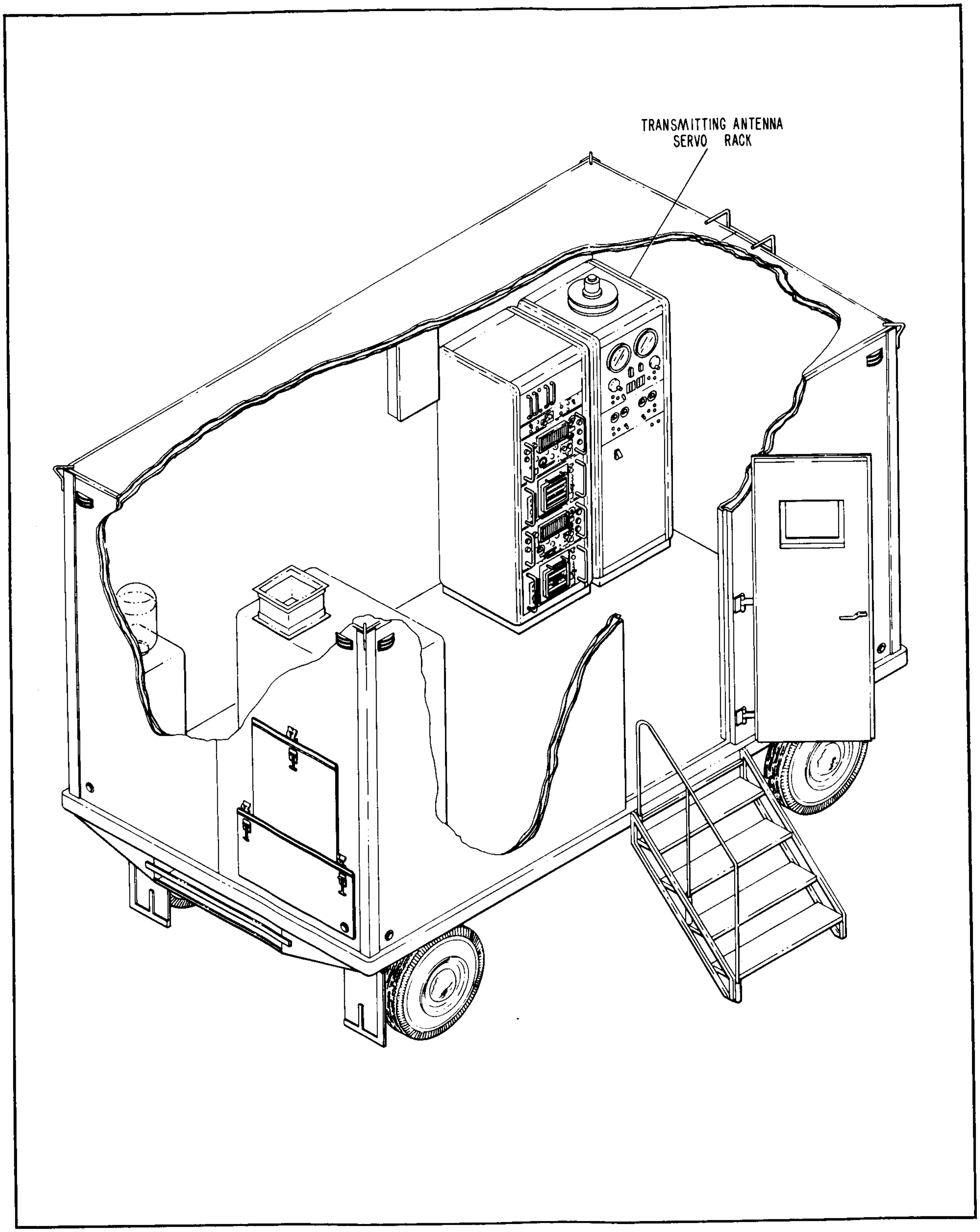



Figure 1-19. Location of Antenna Servo Rack in Transmitter Van

3. RECEIVING ANTENNA

The receiving antenna, not a part of the acquisition system but connected to it, is just off the southeast corner of the telemetry and control building (see figure 1-17).

4. TRANSMITTING ANTENNA

The transmitting antenna, like the receiving antenna, is not a part of the acquisition system but is connected to it. It is located southeast of the telemetry and control building as shown in figure 1-17. The transmitting antenna servo rack is in the transmitting van.

# SECTION II
# INSTALLATION

## 2-1. GENERAL

This section comprises instructions and other information for installing the equipment which makes up the acquisition system. Equipment installation on building floors, on antenna towers, and in other equipment are covered in separate paragraphs.

## 2-2. EQUIPMENT INSTALLATION

### A. FLOOR-MOUNTED EQUIPMENT

#### (1). CONSOLE AND CABINETS

The console and equipment cabinets in the acquisition system comprise one unit. The acquisition data console and the active acquisition aid receiver and servo cabinets are bolted together and installed as a single unit. Figures 1-14, 1-16, and 1-18 show the approximate location of the acquisition system equipment in the site telemetry and control buildings. Figure 2-1 gives the outline dimensions of the console and cabinet unit. The console and cabinets are secured to the floor by anchor bolts. Mounting hole locations and details of anchor bolt installation are shown on figure 2-2. A complete listing of the hardware required for mounting the units is given in table 2-I.

#### (2). AMPLIDYNES

The place of installation of the active acquisition aid amplidynes is shown on figures 1-14, 1-16, and 1-18. Each amplidyne is bolted to a steel channel, which in turn is secured to a concrete pad with anchor bolts. See figures 2-2(B), 2-2 (C) and 2-3 for details of the installation, and refer to table 2-I for the hardware required.

### B. EQUIPMENT ON TOWERS

#### (1). ANTENNA AND PEDESTAL

The active acquisition aid antenna and pedestal are installed on a tower constructed for that purpose. The locations of the towers are shown in figures 1-13, 1-15, and 1-17. For instructions on the installation of the active acquisition aid antenna and pedestal, refer to the applicable equipment manual, listed in table 1-II.

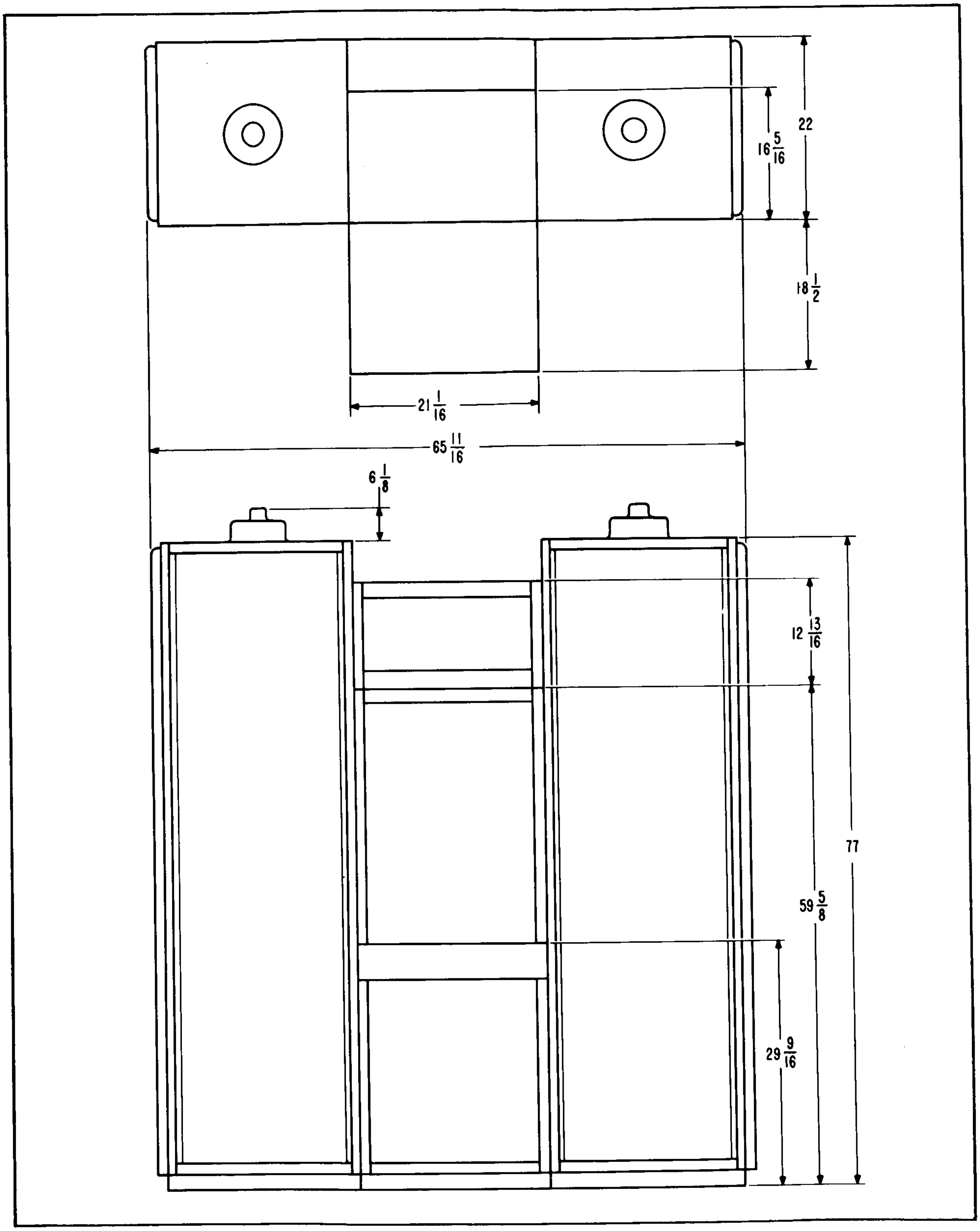



Figure 2-1. Acquisition Data Console, Intercom Cabinet, and Active Acquisition Aid Receiver Cabinet and Servo Cabinet Outline Dimensions

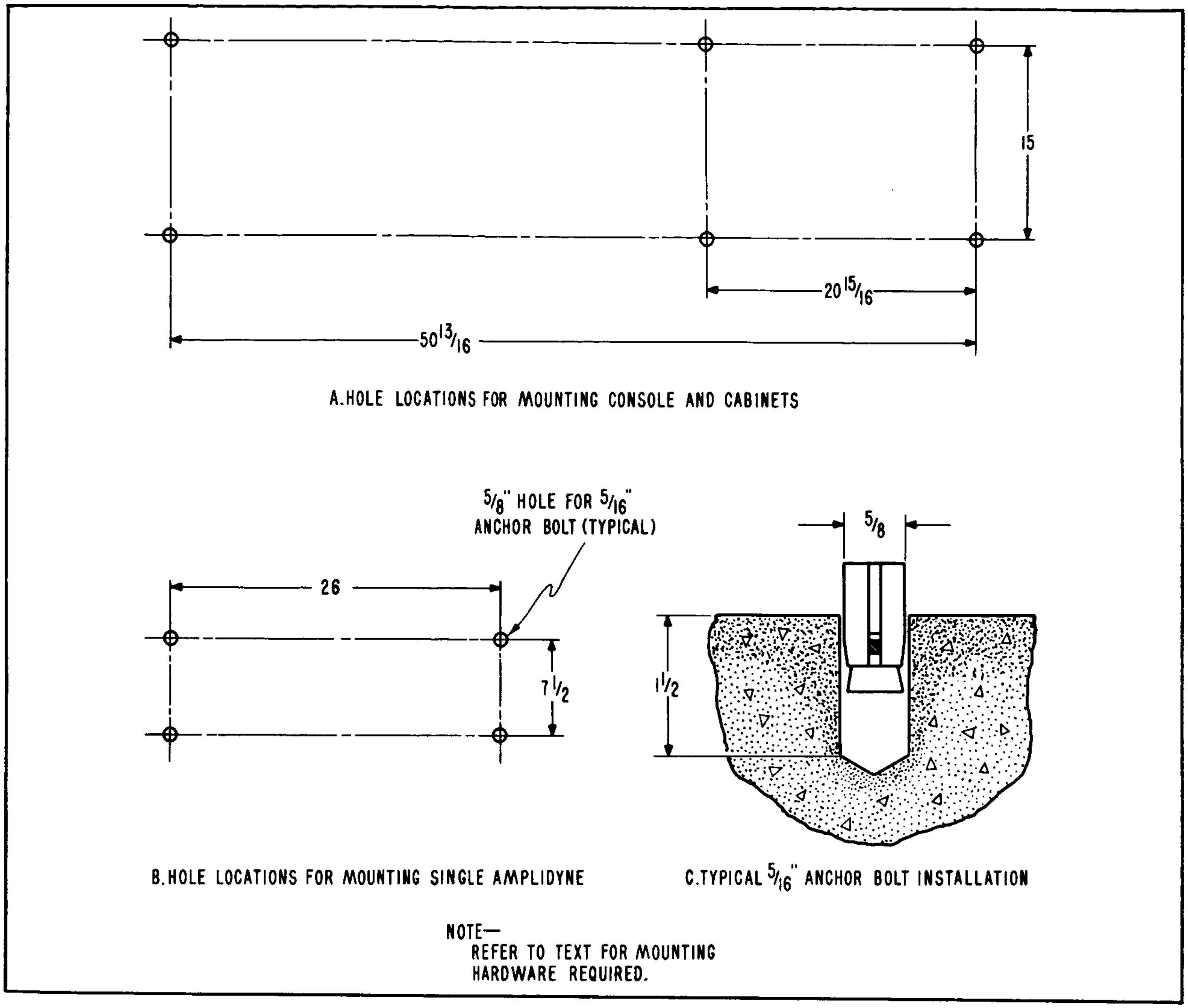



Figure 2-2. Floor and Pad Mounting Hole Locations

(2). RF HOUSING

The active acquisition aid RF housing is installed on the underside of the antenna tower platform in the location shown on figure 2-4. The unit is supported by a special bracket which is fastened to the tower platform. Refer to table 2-I for the installation hardware required.

(3). MULTIPLEXERS

The active acquisition aid multiplexers (triplexer and two diplexers) are, like the RF housing, mounted underneath the antenna tower platform. The triplexer is fastened to a separate bracket, and the two diplexers are fastened to a common mounting plate.

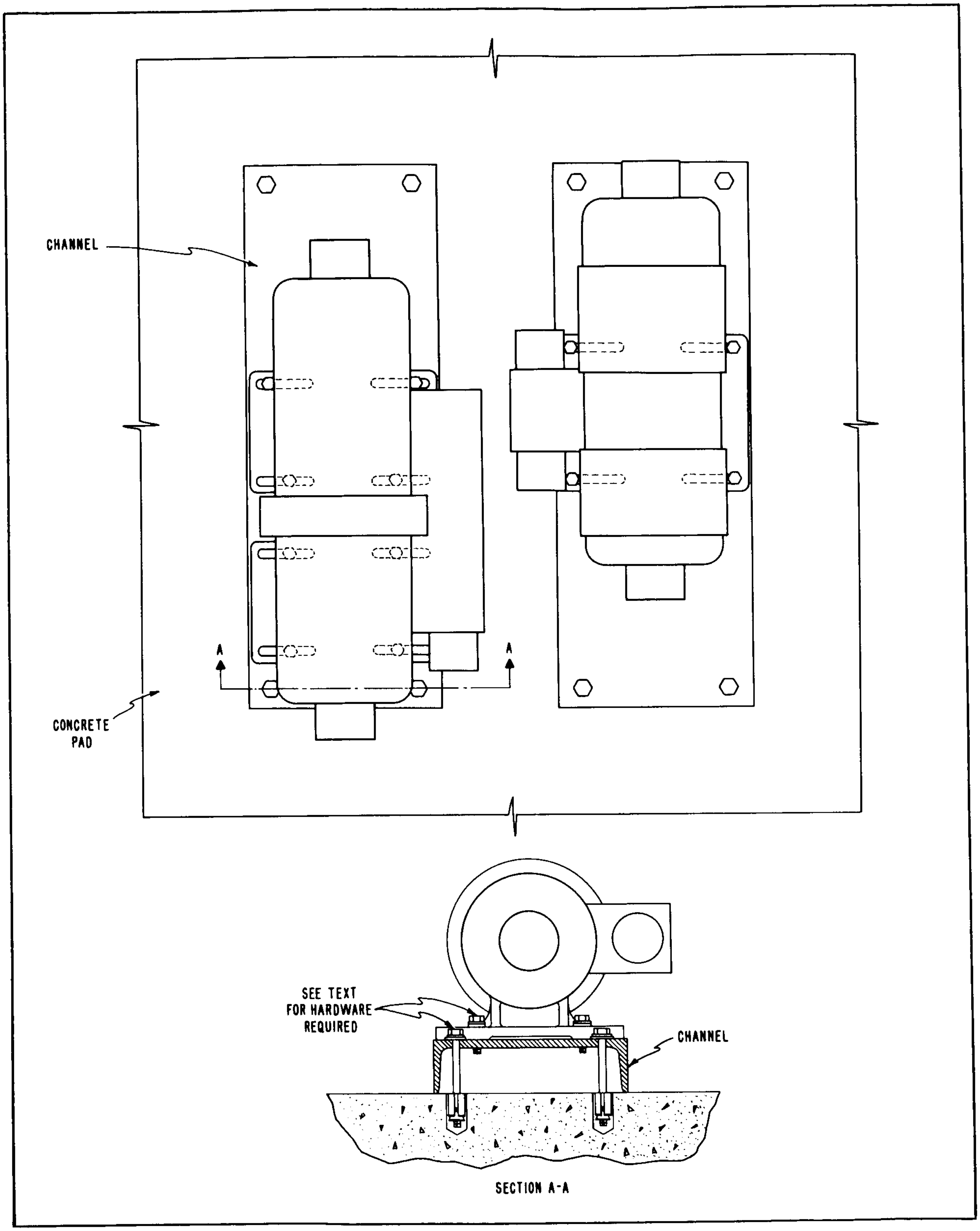



Figure 2-3. Amplidyne Installation

See figure 2-4 for the location of these components, and refer to table 2-I for the hardware required for installation.

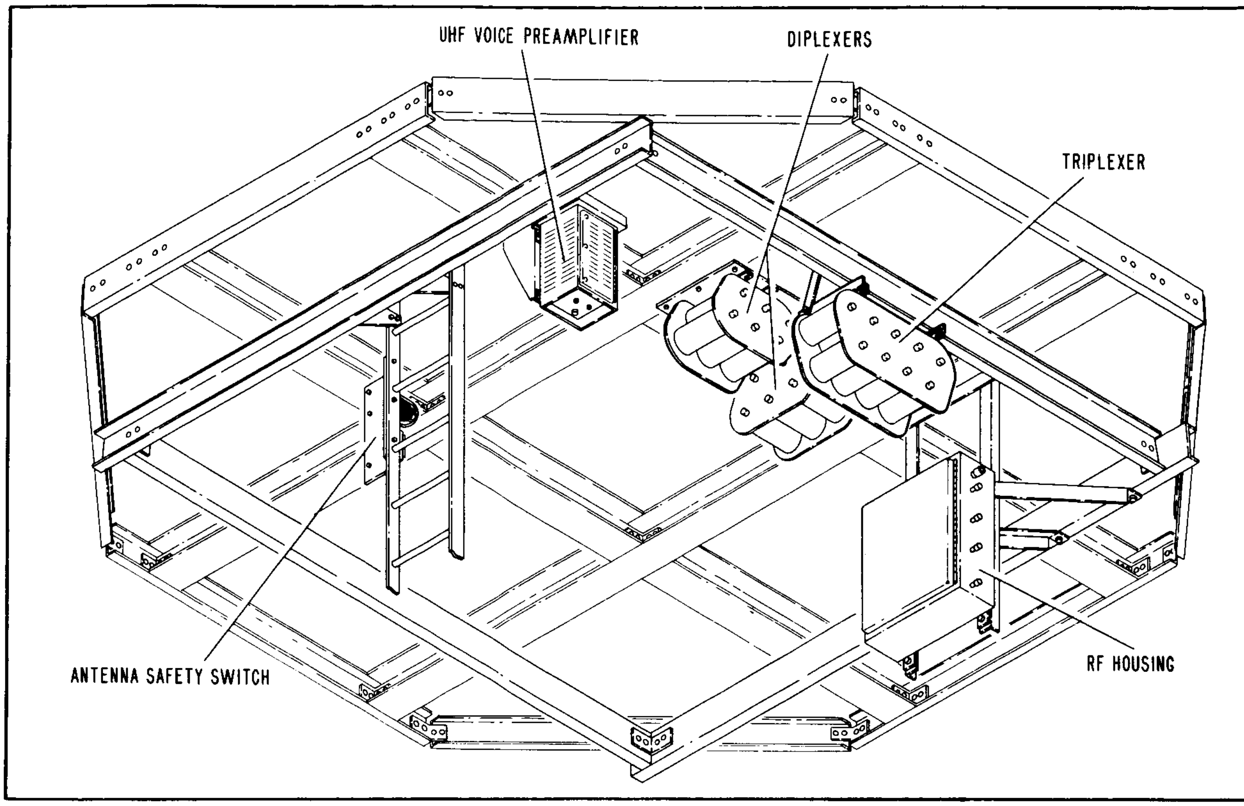



Figure 2-4. Active Acquisition Aid RF Equipment Installation

(4). UHF VOICE PREAMPLIFIER

The UHF voice preamplifier, which is part of the capsule communications system, is installed along with active acquisition aid equipment on the underside of the active acquisition aid antenna tower. (See figure 2-4.) It is supported by a special mounting bracket. Refer to table 2-I for the installation hardware required.

(5). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

An antenna drive power cutoff switch and warning light is mounted near the top of one of the ladders leading to the top of the active acquisition aid antenna platform. The required hardware is listed in table 2-I. See figure 2-4.

(6). BORESIGHT TRANSMITTER AND ANTENNA

The active acquisition aid boresight transmitter and antenna are mounted on the boresight antenna tower, the transmitter on a bracket near the base of the tower, and the antenna on the top of the tower. The locations of the boresight

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE

| Equipment | Figure Ref. | Hardware Name and Description | Part Number | Qty. (Per Unit) |
|---|---|---|---|---|
| Acquisition Data Console and Active Acquisition Aid Receiver and Servo Cabinets | 2-2(A) | Anchor Bolt, 5/16" lead insert | A683322-1 | 6 |
| | | Bolt, 5/16" - 18NC, 1" long | HK936S16-2018 | 6 |
| | | Flat washer, 5/16" | HK779S20-A | 6 |
| | | Lock washer, 5/16" | HK779G20-E | 6 |
| Active Acquisition Aid Azimuth Amplidyne | 2-2(B), 2-2(C), 2-3 | Mounting channel | N683369-1 | 1 |
| | | Anchor bolt, 5/16" lead insert | A683322-1 | 4 |
| | | Bolt, 5/16" -18NC, 4-1/4" long | HK936S68-2018 | 4 |
| | | Bolt, 5/16" -18NC, 1-1/4" long | HK936S20-2018 | 8 |
| | | Flat washer, 5/16" | HK779S20-A | 12 |
| | | Lock washer, 5/16" | HK779G20-E | 12 |
| Active Acquisition Aid Elevation Amplidyne | 2-2(B), 2-2(C), 2-3 | Same as active acquisition aid azimuth amplidyne. | | |
| Active Acquisition Aid Triplexer | 2-4 | Support bracket | N653929-1 | 1 |
| | | Bolt, 1/2" - 13NC, 1-1/4" long | HK936S20-3212 | 4 |
| | | Nut, 1/2" - 13NC | HK775S32-13 | 4 |
| | | Flat washer, 1/2" | HK779S32-A | 4 |
| | | Lock washer, 1/2" | HK799G32-M | 4 |
| | | Bolt, 3/8" -16NC, 1-1/4" long | HK936S20-2416 | 4 |
| | | Nut, 3/8" -16NC | HK775S24-16 | 4 |
| | | Flat washer, 3/8" | HK779S24-A | 4 |
| | | Lock washer, 3/8" | HK779G24-M | 4 |
| Active Acquisition Aid Diplexers | 2-4 | Beam support | L683396-1 | 1 |
| | | Clip angle | C683397-1 | 4 |
| | | Mounting plate | N683395-1 | 1 |
| | | Bolt, 3/8" -16NC, 1-1/4" long | HK936S20-2416 | 29 |
| | | Nut, 3/8" -16NC | HK775S24-16 | 29 |
| | | Flat washer, 3/8" | HK779S24-A | 29 |
| | | Lock washer, 3/8" | HK779G24-M | 29 |

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE (Cont.)

| Equipment | Figure Ref. | Hardware Name and Description | Part Number | Qty. (Per Unit) |
|---|---|---|---|---|
| Active Acquisition Aid RF Housing | 2-4 | Mounting bracket | SK-1000-402 | 1 |
| | | Bolt, 3/8" -16NC, 1-1/2" long | HK936S24-2416 | 3 |
| | | Bolt, 3/8" -16NC, 1-1/4" long | HK936S20-2416 | 6 |
| | | Nut, 3/8" -16NC | HK775S24-16 | 9 |
| | | Flat washer, 3/8" | HK779S24-A | 9 |
| | | Lock washer, 3/8" | HK779G24-M | 9 |
| UHF Voice Preamplifier | 2-4 | Mounting Plate | N683112-1 | 1 |
| | | Bolt, 5/16" -18NC, 1-1/4" long | HK936S20-2018 | 4 |
| | | Bolt, 5/16" -18NC, 7/8" long | HK936S14-2018 | 4 |
| | | Nut, 5/16" -18NC | HK775S20-18 | 8 |
| | | Flat washer, 5/16" | HK779S20--A | 8 |
| | | Lock washer, 5/16" | HK799G20-M | 8 |
| Antenna Drive Power Cutoff Switch and Warning Light | 2-4 | Binder head screws, 10-32, 7/8" long | HK950S28-1032 | 3 |
| | | Hex nut, 10-32 | HK775S10-32 | 3 |
| | | Lock washer, No. 10 | HK799G10-M | 3 |
| Active Acquisition Aid Boresight Transmitter | 2-5 | Mounting channel | N689950-1 | 1 |
| | | Bolt, 1/4" -20NC, 3/4" long | HK936S12-1620 | 6 |
| | | Flat washer, 1/4" | HK779S16-A | 6 |
| | | Lock washer, 1/4" | HK799G16-H | 6 |
| | | Bolt, 3/8" -16NC, 7/8" long | HK936S14-2416 | 4 |
| | | Nut, 3/8" -16NC | HK775S24-16 | 4 |
| | | Flat washer, 3/8" | HK779S24-A | 4 |
| | | Lock washer, 3/8" | HK799G24-H | 4 |
| Active Acquisition Aid Boresight Antenna | 2-5 | Antenna Support | 653792-1 | 1 |
| | | Mounting plate | 653751-2 | 1 |
| | | Clamp | 689834-1 | 2 |
| | | Bolt, 3/8" -16NC, 1" long | HK936S16-2416 | 6 |
| | | Nut, 3/8" -16NC | HK775S24-16 | 4 |
| | | Lock washer, 3/8" | HK799G24-M | 10 |

towers at the sites are shown on figures 1-13, 1-15, and 1-17. The bracket which supports the transmitter and the hardware required for installation are listed in table 2-I. Details of the installation are shown on figure 2-5. The boresight antenna is mounted on top of the boresight tower by means of a special support, mounting plate, and two clamps. These items and the required hardware are listed on table 2-I. See figure 2-5 for details on the antenna installation.

C. SMALL COMPONENTS

(1). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

(a). The synchro reference voltage step-down transformers for the transmitting and receiving antennas are located in the servo racks for these antennas. See figure 2-6. The transformer in each rack is mounted behind the second panel from the bottom of the rack.

(b). The active acquisition aid obtains its synchro reference voltage from the acquisition data console. Therefore, there is no reference voltage transformer associated with the active acquisition aid. The reference voltage step-down transformer for the acquisition data console is supplied as part of the console and requires no separate installation.

## 2-3. INTERCONNECTING CABLING

A. ELECTRICAL INTERCONNECTIONS

An acquisition system interconnecting cabling diagram is included in Section VII (figure 7-15). This diagram shows all the interconnections between the acquisition system and equipment of other systems to which the acquisition system is connected. Detailed interconnecting wiring information is not included in this manual. It is provided in separate books, the "Installation Wiring Information" charts. The part numbers for these charts are listed in table 2-II. Interconnecting wiring information for the transmitter van cable termination box is provided in the Capsule Communications System Manual, MS-102.

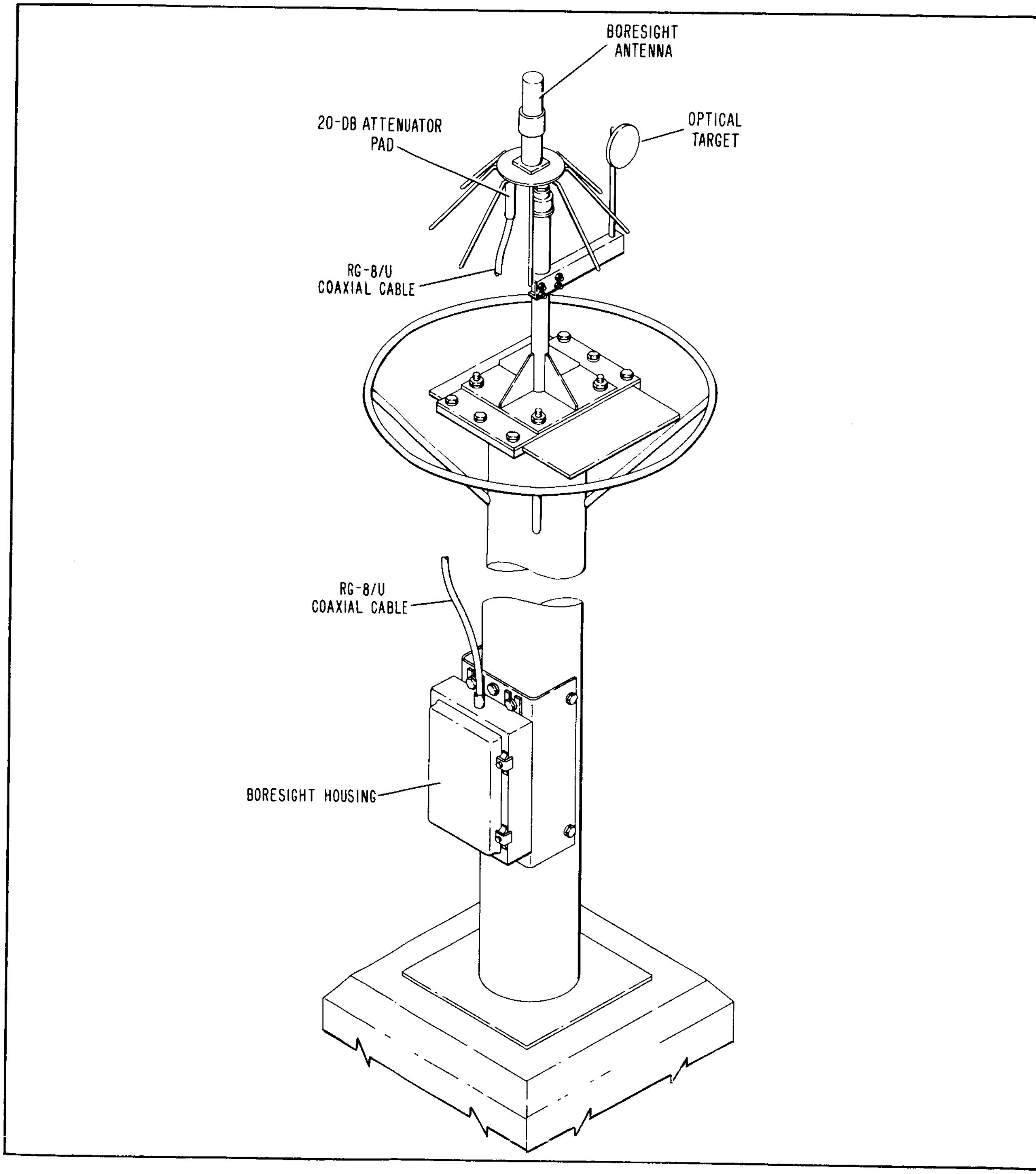



Figure 2-5. Active Acquisition Aid Boresight Transmitter and Antenna Installation

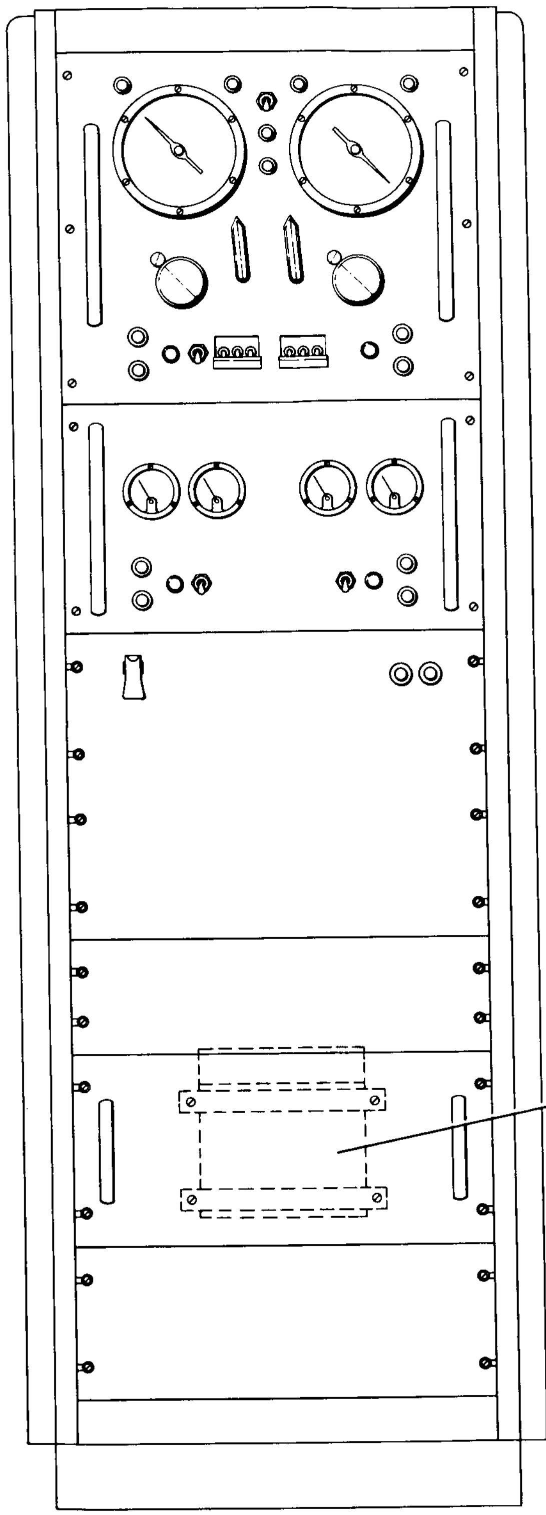



Figure 2-6. Location of Synchro Reference Voltage Step-up and Step-down Transformers in Transmitting and Receiving Antenna Servo Racks

TABLE 2-II. INSTALLATION WIRING INFORMATION CHARTS

| Site | Part Number of Chart |
|---|---|
| Kano, Nigeria | L683173-9 |
| Zanzibar | L683173-10 |
| Canton Island | L683173-14 |

B. CABLE INSTALLATION

The physical installation of equipment interconnecting cabling is not covered in this manual. Information on physical installation of interconnecting cabling is included in the installation wiring information charts (refer to the previous paragraph) and is provided directly to the site on separate drawings.

## 2-4. PRE-OPERATIONAL CHECKS

A. COMPONENT (UNIT) CHECKS

Pre-operational check of the components of the acquisition system other than the acquisition data console are given in the individual equipment manuals. Pre-operational checks for the acquisition data console are described in Section III of this manual.

B. SYSTEM CHECKS

No pre-operational checks are required for the overall acquisition system. Operational system checks are described in Section III. It should be kept in mind that any malfunctions involving synchros which occur the first time the system checks are run are likely to be caused by incorrect interconnecting wiring of the synchro circuits. Refer to Section V and particularly to figure 5-1 for information on trouble shooting synchro circuit malfunctions.

# SECTION III
# SYSTEM OPERATION

## 3-1. GENERAL

A. This section contains a tabulation (table 3-I) and illustrations of the controls on the acquisition data console, initial and normal turn-on procedures for system equipment, system operational checks, and normal and emergency system operating procedures. Complete, detailed procedures are included for the acquisition data console only, since detailed procedures for other system equipments are in the various equipment manuals (listed in table 1-II).

B. For proper operation of the acquisition system, it is necessary that all operators involved, and particularly the acquisition data console operator, have a thorough knowledge and understanding of the makeup, capabilities, and limitations of the overall system and the equipment connected to it. Refer to Sections I and IV of this manual.

## 3-2. INITIAL TURN-ON PROCEDURE

The procedure described in this paragraph is to be followed the first time the equipment is turned on after installation or major repair. For initial turn-on procedures for equipment other than the acquisition data console, see the applicable equipment manuals. Proceed as follows for the acquisition data console:

### A. EXTERNAL POWER CONNECTIONS

(1). With the acquisition data console circuit breaker on the site power panel turned on, check to see that 115 VAC is applied to console terminal board TB6001, terminals 1 and 2.

(2). Check to see that approximately 480 VAC is applied to the console on TB6001-7 and -8.

(3). Check the secondary voltage of transformer T6001. It should be between 115 and 120 VAC. If this voltage is less than 115 VAC, move the lead connected to terminal 4 of transformer to terminal 5.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS

| Name | Function |
|---|---|
| ACQUISITION DATA PANEL NO. 1 (See figure 3-1.) | |
| ACTIVE ACQUISITION AID "SOURCE" SWITCH | Connects data from the active acquisition aid to the acquisition bus. |
| ACTIVE ACQUISITION AID MODE INDICATORS | Indicate whether the active acquisition aid is in automatic tracking, slaved, or manual mode of operation. |
| ACTIVE ACQUISITION AID "ELEVATION" DISPLAY | Shows the elevation angle of the active acquisition aid antenna. |
| ACTIVE ACQUISITION AID "CABLE WRAP" INDICATORS | Indicate whether the active acquisition aid antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel. |
| ACTIVE ACQUISITION AID "AZIMUTH" DISPLAY | Shows the azimuth angle of the active acquisition aid antenna. |
| RCVR ANT "CABLE WRAP" INDICATORS | Indicate whether the receiving antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel. |
| RCVR ANT "AZIMUTH" DISPLAY | Shows the azimuth angle of the receiving antenna. |
| XMTR ANT "CABLE WRAP" INDICATORS | Indicate whether the transmitting antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel. |
| XMTR ANT "AZIMUTH" DISPLAY | Shows the azimuth angle of the transmitting antenna. |
| XMTR ANT "ELEVATION" DISPLAY | Shows the elevation angle of the transmitting antenna. |
| XMTR ANT MODE INDICATORS | Indicate whether the transmitting antenna is in the slaved or manual mode of operation. |
| RCVR ANT MODE INDICATORS | Indicate whether the receiving antenna is in the slaved or manual mode of operation. |
| RCVR ANT "ELEVATION" DISPLAY | Shows the elevation angle of the receiving antenna. |
| ACQUISITION DATA PANEL NO. 2 (See figure 3-2.) | |
| MANUAL INPUT "ELEVATION" DISPLAY | Shows angle to which the azimuth manual input transmitter has been turned. |

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

| Name | Function |
| --- | --- |
| ACQUISITION DATA PANEL NO. 2 (See figure 3-2.) (Cont.) | |
| MANUAL INPUT "SOURCE" SWITCH | Connects data from the manual input transmitters to the acquisition bus. |
| MANUAL INPUT "AZIMUTH" DISPLAY | Shows angle to which the azimuth manual input transmitter has been turned. |
| "NO DATA ON BUS" INDICATOR | Indicates that neither of the "SOURCE" switches has been depressed. |
| TM CHANNEL SELECTOR SWITCH | Selects telemetry receiver as source of audio signal for monitoring and applies 28 VDC to indicator lamps adjacent to signal strength meter which is connected to the audio source selected. |
| "28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR | Turns on power supply No. 1 and indicates whether it is operating properly. |
| "VOLUME" CONTROL | Adjusts volume of audio signal being monitored. |
| "28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR | Turns on power supply No. 2 and indicates whether it is operating properly. |
| AZIMUTH "MANUAL INPUT" SYNCHRO HANDWHEEL | Turns the azimuth manual input transmitter. |
| ELEVATION "MANUAL INPUT" SYNCHRO HANDWHEEL | Turns the elevation manual input transmitter. |
| DUAL POWER SUPPLY (See figure 3-3.) | |
| OFF-ON SWITCH | Controls application of primary power to the dual power supply. |
| FUSES | Contain primary power line fuses and indicators to show when a fuse is blown. |
| POWER-ON INDICATOR | Indicates the application of primary power to the dual power supply. |
| SIGNAL STRENGTH METER PANEL (See figure 3-4) | |
| RCVR ANT FREQ. B TLM RCVR "SIGNAL STRENGTH" METER | Indicates strength of signal at frequency B telemetry receiver connected to the receiving antenna. |

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

| Name | Function |
|---|---|
| SIGNAL STRENGTH METER PANEL (See figure 3-4.) (Cont.) | |
| AAA ANT FREQ. B TLM RCVR "SIGNAL STRENGTH" METER | Indicates strength of signal at frequency B telemetry receiver connected to the active acquisition aid antenna. |
| RCVR ANT FREQ. A TLM RCVR "SIGNAL STRENGTH" METER | Indicates strength of signal at frequency A telemetry receiver connected to the active acquisition aid antenna. |
| AAA ANT FREQ. A TLM RCVR "SIGNAL STRENGTH" METER | Indicates strength of signal at frequency A telemetry receiver connected to the active acquisition aid antenna. |
| CALIBRATION CONTROLS | Permit calibration of the meters to read actual signal strength. |
| PILOT LAMPS | Correlate audio signal source with signal strength indication. |
| AUDIO AMPLIFIER (See figure 3-5.) | |
| SPEAKER "OFF-ON" SWITCH | Connects audio output to speaker. |
| "PHONE JACK" | Permits monitoring audio with headset. |
| "1 AMP" FUSE | Primary power fuse for audio amplifier. |
| AMPLIFIER "OFF-ON" SWITCH | Primary power switch for audio amplifier. |
| INTERCOM PANEL (See figure 3-6.) | |
| For information on the intercom panel refer to the Intrasite PBX and Intercom System Manual, MS-109. | |

B. <u>28 VDC POWER SUPPLY</u>

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 switch on acquisition data panel number 2 (figure 3-2). This action turns on power supply number 1. The on-failure indicator for power supply number 1 should be green and the indicator for power supply number 2 should be red.

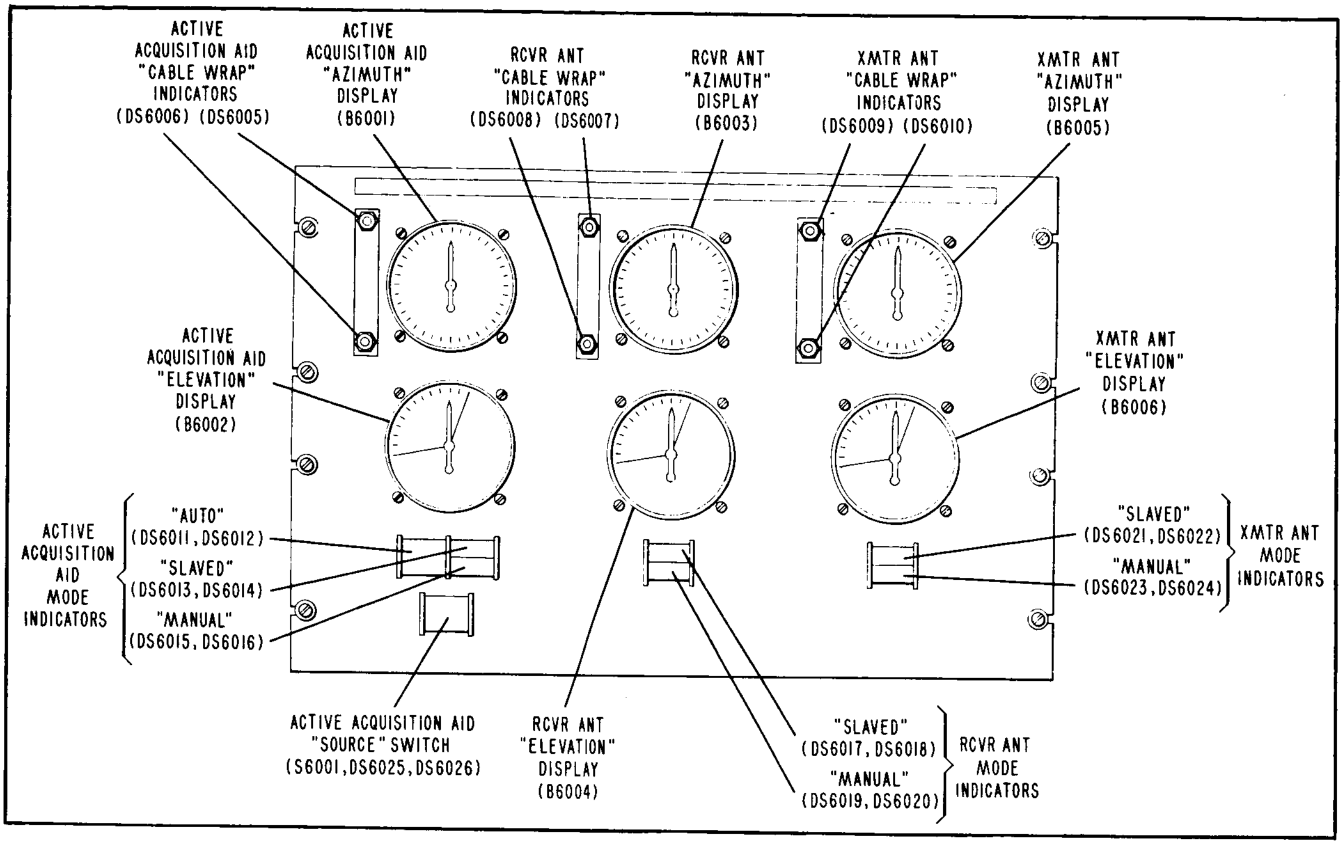



**Figure 3-1. Acquisition Data Panel Number 1**

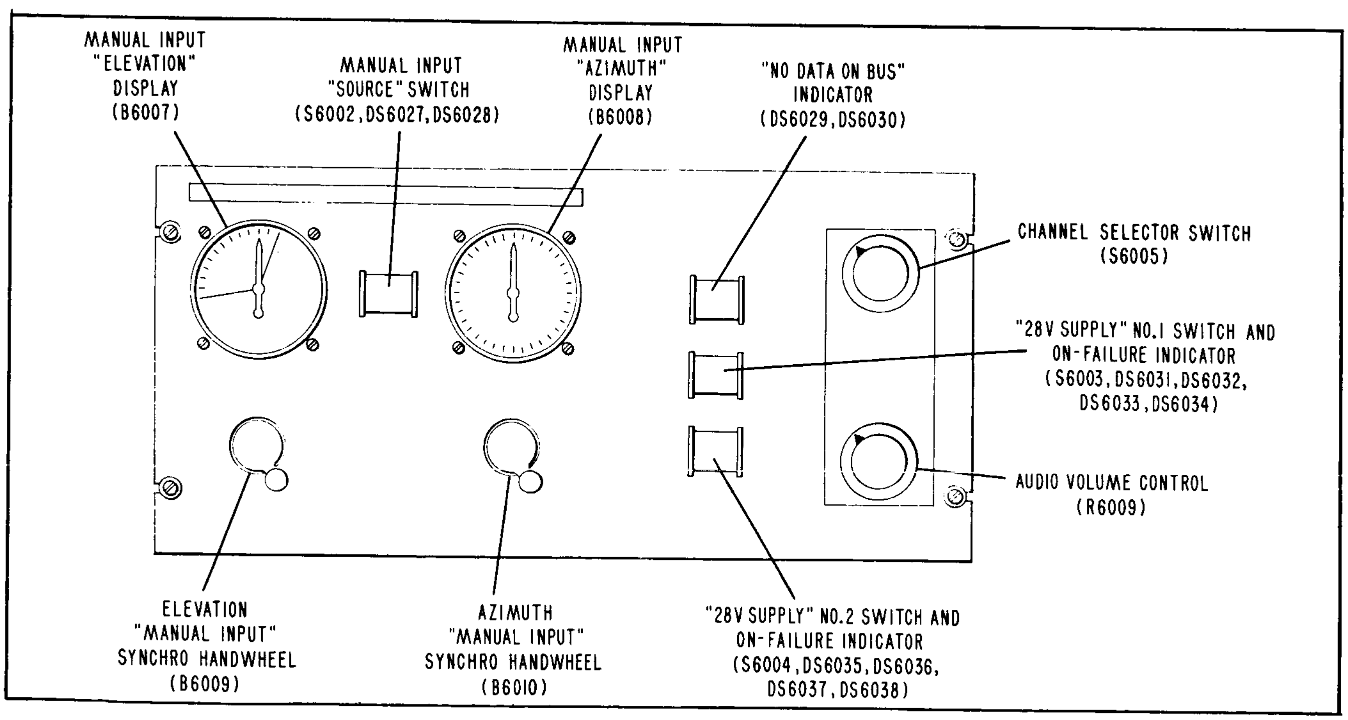



**Figure 3-2. Acquisition Data Panel Number 2**

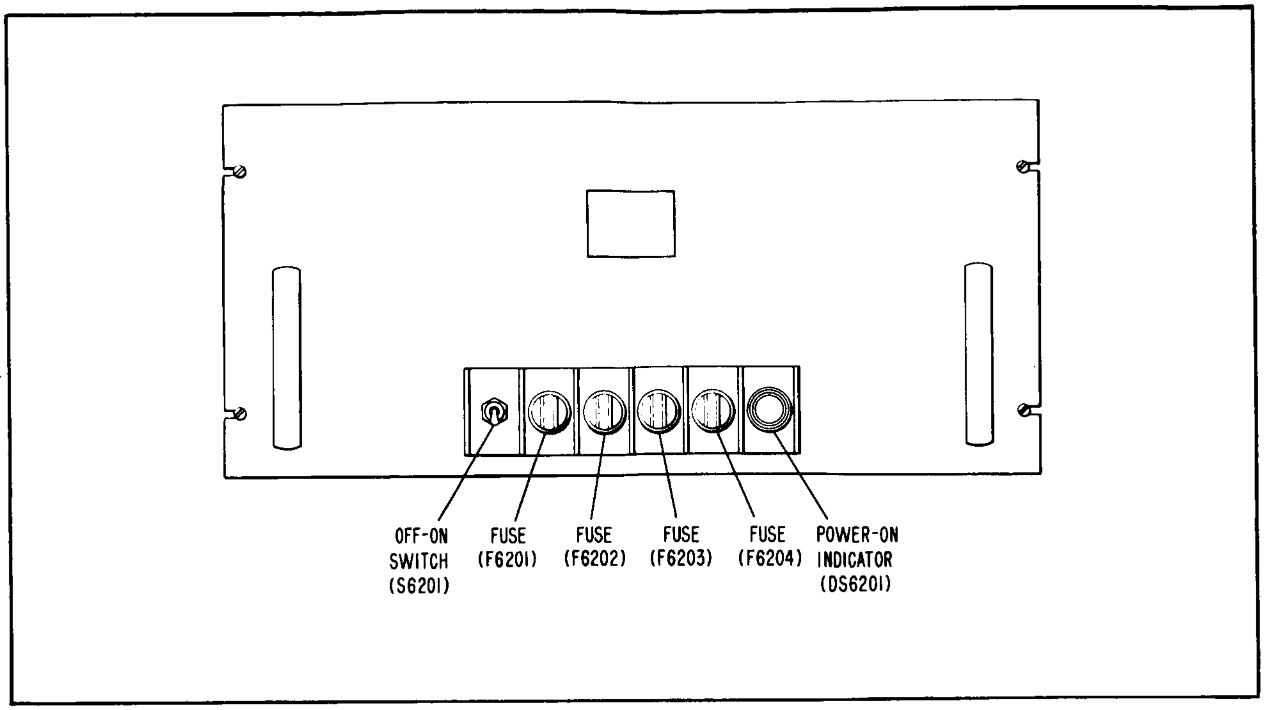



Figure 3-3. Dual Power Supply

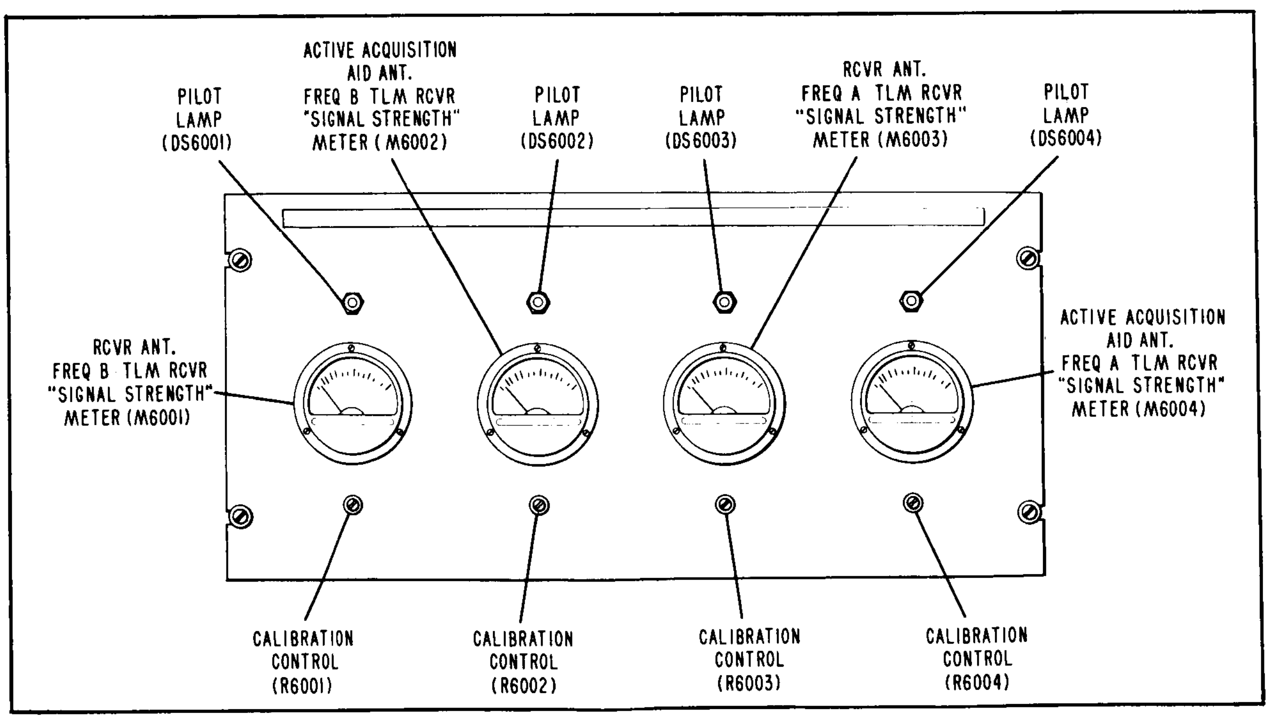



Figure 3-4. Signal Strength Meter Panel

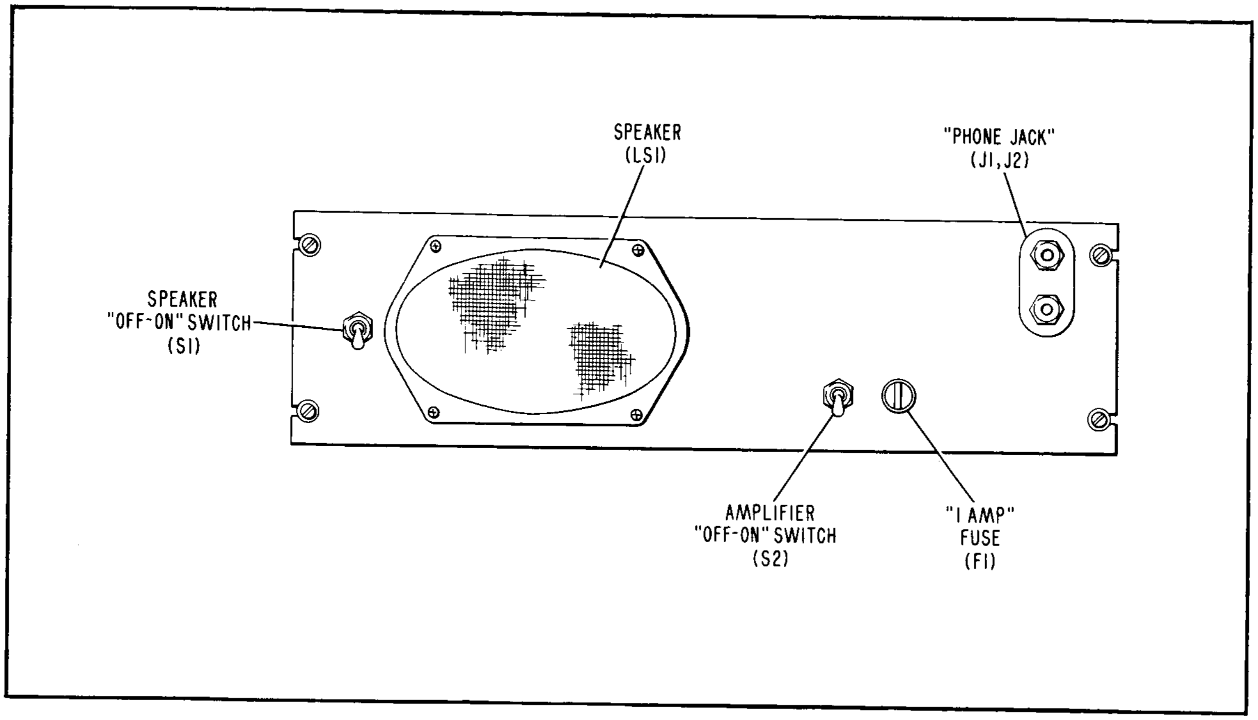



Figure 3-5. Audio Amplifier

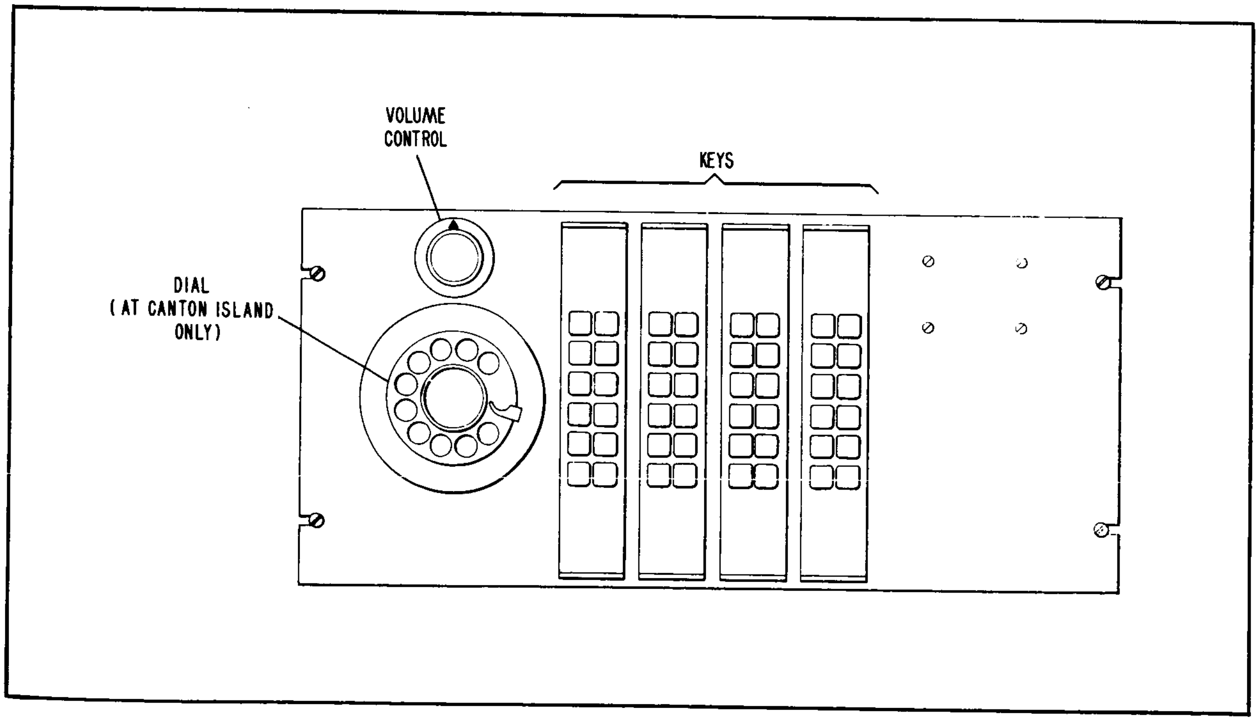



Figure 3-6. Intercom Panel

(4). Remove the display screens from both of the on-failure indicators. Check to see that all color filters are in place (two red and two green in each indicator). The two lamps in the power supply number 1 indicator with green color filters should be lit, and the two lamps in the power supply number 2 with red color filters should be lit.

(5). Check and if necessary adjust the output voltage of power supply number 1 in accordance with the instructions in paragraph 5-4.D.(2).

(6). Turn off power supply number 1 by turning off the OFF-ON switch on the dual power supply panel.

**Note**

> Due to the long time constant of the power supply filter, several seconds are required after turning off the power supply before the holding coil of the "28V SUPPLY" switch releases.

(7). Turn on the OFF-ON switch on the dual power supply panel.

(8). Depress the "28V SUPPLY" number 2 switch on the acquisition data panel. This action turns on power supply number 2. The on-failure indicator for power supply number 2 should be green and the indicator for power supply number 1 should be red.

(9). Check the indicators of both power supplies to see that both of the lamps with green color filters in power supply number 2 indicator are lit and that both of the lamps with the red color filters in the power supply number 1 indicators are lit.

(10). Check and if necessary adjust the output voltage of power supply number 2 in accordance with the instructions in paragraph 5-4.D.(2).

(11). Depress the "28V SUPPLY" number 1 switch. The on-failure indicators for both power supplies should be green.

C. INDICATORS

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches on acquisition data panel number 2 (figure 3-2).

(4). Check the operation of each of the console indicators by completing its circuit with a temporary jumper to a 28 VDC source (e.g., TB6001-3). The indicators to be checked in this manner and the associated terminals to be jumpered to 28 VDC are listed in table 3-II. As each of the indicators is lighted, remove its display screen to see that both color filters are in place and that both lamps are working (except for the cable wrap indicators, which have no color filter and only one lamp).

D. SOURCE SWITCHES (Figure 3-1)

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3) and depress "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel number 2.

(3). The "NO DATA ON BUS" indicator should be lit. Remove the display screen and check that both color filters are in place and that both lamps are lit.

(4). Depress the manual input "SOURCE" switch. The "NO DATA ON BUS" indicator lamp should go out. The switch should remain depressed, and its indicator lamps should light. Check the color filters and lamps with the display screen removed.

(5). Depress the active acquisition aid "SOURCE" switch. The manual input "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The active acquisition aid "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

TABLE 3-II. INDICATOR CHECKOUT PROCEDURE

| Indicator | Terminal to be Jumpered |
|---|---|
| Active Acquisition Aid "CABLE WRAP" (DS6005) | TB6002-5 |
| Active Acquisition Aid "CABLE WRAP" (DS6006) | TB6002-6 |
| Active Acquisition Aid "AUTO" (DS6011, DS6012) | TB6002-8 |
| Active Acquisition Aid "SLAVED" (DS6013, DS6014) | TB6002-1 |
| Active Acquisition Aid "MANUAL" (DS6015, DS6016) | TB6002-3 |
| Receiving Antenna "CABLE WRAP" (DS6007) | TB6003-5 |
| Receiving Antenna "CABLE WRAP" (DS6008) | TB6003-7 |
| Receiving Antenna "SLAVED" (DS6017, DS6018) | TB6003-1 |
| Receiving Antenna "MANUAL" (DS6019, DS6020) | TB6003-3 |
| Transmitting Antenna "CABLE WRAP" (DS6009) | TB6004-5 |
| Transmitting Antenna "CABLE WRAP" (DS6010) | TB6004-7 |
| Transmitting Antenna "SLAVED" (DS6021, DS6022) | TB6004-1 |
| Transmitting Antenna "MANUAL" (DS6023, DS6024) | TB6004-3 |

E. SYNCHROS

There is no convenient means of performing checks on the synchros without operation of the entire acquisition system and all of the equipment connected to it. Therefore, the initial check of these items should be made during the first system operational check (paragraph 3-5).

F. SIGNAL STRENGTH METERS

As part of the initial turn-on procedure, the meters on the acquisition data console signal strength meter panel (figure 3-4) require calibration. Refer to paragraph 5-4.G. for detailed instructions. Proceed as follows to check the operation of the pilot lights on the meter panel:

(1). With the active acquisition aid energized, turn SELECTOR switch S6005 on acquisition data panel number 2 to positions 1, 2, 3, and 4. Pilot lamps DS6001, DS6002, DS6003 and DS6004 on the signal strength meter panel should light in succession. See figure 3-4. (There is no pilot lamp associated with position 5.)

G. AUDIO AMPLIFIER

Check the audio amplifier as part of the first system operational check, paragraph 3-5.

H. INTERCOM

For information on the intercom system, refer to the Intrasite PBX and Intercom System Manual, MS-109.

## 3-3. NORMAL TURN-ON PROCEDURE

A. For normal turn-on procedures for all equipment other than the acquisition data console, see the applicable equipment manuals.

B. For normal turn-on of the acquisition data console, proceed as follows:

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches (figure 3-2). Both of the associated indicators should come on and should be green. The acquisition data console is now ready for operation.

## 3-4. NORMAL OPERATING PROCEDURE

Paragraph 3-4.A. presents operating instructions for the acquisition system without specifying when and under what conditions the various functions are to be performed. The latter information is given in paragraph 3-4.B.

A. OPERATING INSTRUCTIONS

(1). Turn on the acquisition data console in accordance with paragraph 3-3.

(2). Turn on the audio amplifier on the console by turning on "OFF-ON" switch S2 (figure 3-5).

(3). If the manual input is to be used, set the handwheels (figure 3-2) so that the associated displays are at the desired azimuth and elevation.

(4). By intercom, instruct the operators of the receiving antenna and the transmitting antenna to disconnect their equipment from the acquisition bus and stand by for further instructions. Disconnect the active acquisition aid from the acquisition bus.

(5). Check the d-c mode indications (figure 3-1) from the receiving antenna and the transmitting antenna to see that the antennas are in the manual (local input) mode of operation. The active acquisition aid should be in the manual or automatic mode.

**CAUTION**

The purpose of disconnecting equipment from the acquisition bus before switching data is to avoid sudden, large changes in the inputs to the antenna positioning system. Such step-function inputs impose unnecessary wear on the equipment, and under certain circumstances can drive the antennas into their azimuth or elevation limit stops.

(6). Connect the desired source of data (manual or active acquisition aid) to the acquisition bus by depressing the proper "SOURCE" switch. The source switch indicator should light and the switch should remain depressed after being released. The "NO DATA ON BUS" indicator should go out.

(7). By intercom, instruct the operators of the receiving and transmitting antennas to set their antennas to the approximate azimuth and elevation which have been connected to the bus. If the active acquisition aid is not the source of the data on the bus, set its antenna to the azimuth and elevation settings on the bus. The azimuth and elevation data connected to the bus are shown on the console displays of the selected source (figures 3-1 and 3-2).

(8). Check the position of the antennas on the console displays and then instruct the operators that they may slave their antennas to the acquisition bus. (Table 3-III gives the name, location, and proper position or condition of the various controls used for selecting the operating modes of the various pieces of equipment in or connected to the acquisition system.)

**CAUTION**

Be sure that the positions of the active acquisition aid, receiving, and transmitting antennas are correct before they are slaved to the acquisition bus. Otherwise, one or more of them may be driven into its azimuth or elevation limit stops.

TABLE 3-III. MODE INDICATING CONTROLS

| Equipment | Mode | Name of Control | Location | Position for Mode Operation |
|---|---|---|---|---|
| Active Acquisition Aid | Manual (Note 1) | "ELEVATION LOCAL-REMOTE" switch | Servo Cabinet Control Indicator Unit | "LOCAL" |
| | | "AZIMUTH LOCAL-REMOTE" switch | Servo Cabinet Control Indicator Unit | "LOCAL" |
| | Slaved (Note 1) | "ELEVATION LOCAL-REMOTE" switch | Servo Cabinet Control Indicator Unit | "REMOTE" |
| | | "AZIMUTH LOCAL-REMOTE" switch | Servo Cabinet Control Indicator Unit | "REMOTE" |
| | Automatic (Note 1) | "ELEVATION AUTO" switch | Servo Cabinet Meter and Switch Panel | "ON" |
| | | "AZIMUTH AUTO" switch | Servo Cabinet Meter and Switch Panel | "ON" |
| Receiving Antenna | Manual | "ELEVATION LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "LOCAL" |
| | | "AZIMUTH LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "LOCAL" |
| | Slaved (Note 2) | "ELEVATION LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "REMOTE" |
| | | "AZIMUTH LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "REMOTE" |
| Transmitting Antenna | Manual | "ELEVATION LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "LOCAL" |
| | | "AZIMUTH LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "LOCAL" |
| | Slaved (Note 2) | "ELEVATION LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "REMOTE" |

TABLE 3-III. MODE INDICATING CONTROLS (Cont.)

| Equipment | Mode | Name of Control | Location | Position for Mode Operation |
|---|---|---|---|---|
| Trans-mitting Antenna (Cont.) | Slaved (Note 2) | "AZIMUTH LOCAL-REMOTE" switch | Servo Rack Control Indicator Unit | "REMOTE" |

Notes: 1. For either a "MANUAL" or "SLAVED" indication on the acquisition data console, both the active acquisition aid "ELEVATION AUTO" and "AZIMUTH AUTO" switches must be in the "OFF" position. If either "AUTO" switch is in the "ON" position, an "AUTO" indication is given on the acquisition data console. Furthermore, for a "SLAVED" indication, both the azimuth and elevation "LOCAL-REMOTE" switches must be in the "REMOTE" position.

2. For a "SLAVED" indication on the acquisition data console, both switches must be in the "REMOTE" position. Otherwise, a "MANUAL" indication is given.

(9). Check the d-c mode indicators to see that the transmitting and receiving antennas are slaved to the acquisition bus. If the manual input has been selected as the source of data, slaving of the active acquisition aid to the bus is at the option of the acquisition data console operator.

**CAUTION**

Do not at any time slave the active acquisition aid to the acquisition bus when it is the source of the data on the bus. To do so is likely to result in equipment damage.

(10). Check the console displays of the slaved antennas to see that each of them is in the proper location in regard to its cable wrap limits. The upper "CABLE WRAP" indicator should be lit if the pointer of the associated "AZIMUTH" display is in the upper half of the dial, and the lower indicator would be lit if the pointer is in the bottom half of the dial. (Refer to paragraph 4-2.B.(4). and figure 4-8 for complete information on antenna position relative to cable wrap limits.)

(11). Check the system slaving accuracy: The console displays of data from the slaved antennas should not differ by more than 3.0 degrees from the console displays of data from the selected source.

(12). To change from one source of acquisition bus data to another, proceed as follows:

(a). Check the azimuth displays of the two data sources (the one to be switched off the bus and the one to be switched onto the bus) to see that switching from one to the other will not drive the slaved antennas into their limit stops. Synchro devices and servo systems using them always turn in the direction which results in the lesser amount of rotation in turning to a new, switched-in position; when a synchro receiver is switched to a transmitter with a position different from that of the receiver, the receiver always turns 180 degrees or less—never more than 180 degrees. Thus, if a limit lies between the positions of the slaved antennas and the new source in the direction of lesser rotation, switching to the new source will drive the slaved antennas into their limits. When this circumstance exists, follow the procedure below before switching:

1. If manual input data is to be switched onto the bus (data from the acquisition aid is on the bus and is to be switched off): Turn the manual input to approximately the same position as the data already on the bus.

2. If active acquisition aid data is to be switched onto the bus (manual input data is on the bus and is to be switched off): Turn the manual input (and the antennas slaved to it) to the approximate position of the new source (active acquisition aid). Turn the manual input in the direction which results in the slaved antennas being in the same position relative to their cable wrap limits as is the active acquisition aid antenna.

(b). Connect the new data source to the acquisition bus by depressing the appropriate "SOURCE" switch. This action also disconnects the data previously on the bus.

(c). If manual input data has been switched onto the bus, but the manual input has been turned away from the desired position per step (a).1, set the manual input to the desired position.

(d). Check the condition of cable wrap and system slaving accuracy as directed in preceding steps (10) and (11).

B. OPERATING CRITERIA

The preceding paragraph has described how to perform various functions in the operation of the acquisition system. This paragraph describes when and under what conditions the functions are to be performed.

(1). PREPARATION FOR CAPSULE PASS

(a). Perform the system operational checks described in paragraph 3-5.

(b). Set the acquisition data console manual input in accordance with predicted data.

(c). Connect the manual input to the acquisition bus and notify the appropriate operators to slave all antennas to the bus.

(2). INITIAL ACQUISITION - ACTIVE ACQUISITION AID

(a). In the Mercury capsule there are two telemetry transmitters which operate at different frequencies in the 225- to 260-megacycle band. The transmitters operate at the same power, and normally either frequency may be used in tracking the capsule. Therefore, for initial acquisition and subsequent tracking, the active acquisition aid may be set at either frequency unless difficulty in acquisition and tracking is encountered. If difficulty is encountered, try the other frequency to see if better results are obtained.

(b). Watch the signal strength indicators and panalyzer and listen for telemetry audio. These will be the first indications that the capsule is in range.

(c). As soon as there are indications that a signal is being received, switch the active acquisition aid into automatic tracking and closely monitor its action as shown on the synchro displays.

(d). At low elevation angles the active acquisition aid may track a signal reflected from the ground. Therefore, closely monitor the synchro displays, particularly the elevation display. If the indicated elevation angle goes below the known horizon, switch to the manual elevation mode and position the antenna for minimum elevation error signal indication at an elevation above the horizon. Manually track the capsule in elevation until it is a few degrees higher and then switch back to fully automatic tracking (both channels in automatic).

(e). Carefully monitor the status of tracking with the active acquisition aid. This status information is especially important during the critical, initial acquisition phase of the operation. As soon as fully automatic tracking is achieved and the quality of the track is verified by observation of the synchro displays, notify all system operators of this fact.

(3). INITIAL ACQUISITION - ACQUISITION DATA CONSOLE

(a). As soon as the active acquisition aid is tracking the capsule either automatically, manually with error signal indications, or manually with signal strength indication, switch the active acquisition aid data onto the acquisition bus. Data from the active acquisition aid when it is tracking in any of these modes is generally more accurate than the manual input settings on the acquisition data console.

(4). TRACKING

(a). The active acquisition aid tracks the capsule during the entire capsule pass, thus providing pointing data to the receiving and transmitting antennas.

(b). Should the active acquisition aid lose the track, proceed as follows:

1. Switch acquisition data console manual input data onto bus.

2. Set the manual input to the best position (estimated or in accordance with predicted data if available) for re-acquisition.

3. As soon as the active acquisition aid re-acquires the capsule, switch data from it onto the acquisition bus.

3-5. SYSTEM OPERATIONAL CHECKS

This paragraph describes the checks to be performed to ascertain that the acquisition data console and the overall acquisition system are in satisfactory operating condition. Detailed procedures for equipment other than the acquisition data console are given in the applicable individual equipment manuals. All of the checks for each individual piece of equipment and for the overall system are to be performed after initial turn-on of the equipment and again shortly before each Mercury operation. Only the operations to be performed are described in this paragraph. For detailed instructions on how to carry out the operations, refer to paragraph 3-4.

A. D-C INDICATIONS

(1). Check the console 28 VDC power supply and source switches in accordance with the instructions in paragraphs 3-2.B. and D.

(2). Direct the operators of the transmitting and receiving antennas to switch their equipment successively to all modes of operation and do the same for the active acquisition aid antenna; "AUTO," "SLAVED" and "MANUAL" for the active acquisition aid, and "SLAVED" and "MANUAL" for the transmitting and receiving antennas. The equipment controls which produce these indications are listed in table 3-III. As the operating modes are switched, check the appropriate console d-c mode indicators (figures 3-1 and 3-2) to see that they light when they should. While each indicator is lit, remove the display screen and see that both color filters are in place and that both lamps are lit.

(3). Set the active acquisition aid antenna to approximately 260 degrees and slowly rotate it in the clockwise (increasing azimuth) direction. Direct the operators of the receiving and transmitting antennas to do the same. As each antenna passes 270 degrees, the associated upper (clockwise indicating) cable wrap indicator on the acquisition data console should light. Set the active acquisition aid and direct the operators of the transmitting and receiving antennas to set their antennas at approximately 280 degrees and then slowly rotate them in the counter-clockwise direction. As each antenna passes 270 degrees, the associated lower cable wrap indicator should light.

B. SYNCHROS

(1). Set the acquisition data console manual input to zero degrees azimuth and elevation and switch this data onto the acquisition bus.

(2). Direct the operators of the transmitting and receiving antennas to slave their equipment to the acquisition bus, and slave the active acquisition aid to the acquisition bus.

(3). Check the displays of antenna position on the acquisition data console and have the other equipment operators check their local displays. All of the antenna position displays should agree with the manual input displays within ±3.0 degrees.

(4). With the acquisition data console handwheel change the azimuth manual input from zero to 360 degrees in 30-degree steps and change the elevation manual input from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the antenna position displays for agreement with the manual input displays as in the preceding paragraph.

(5). With at least one antenna slaved to the bus switch data from the active acquisition aid onto the acquisition bus. Manually vary the active acquisition aid through 360 degrees in azimuth and 90 degrees in elevation. At each 30-degree step in azimuth and elevation check the console displays from the active acquisition aid and from the slaved antenna. They should agree within ±3.0 degrees.

C. SIGNAL STRENGTH METERS

Check the calibration of the signal strength meters in accordance with the instructions in paragraph 5-4. G.

D. AUDIO AMPLIFIER

With an r-f signal generator connected to the telemetry receivers in the same manner as for signal strength calibration (refer to paragraphs 5-4. G.), set the signal generator output level to 100 microvolts with audio modulation. This signal into the telemetry receivers should provide a clearly audible output from the acquisition data console audio amplifier, both through the speaker and into a headset. Check each telemetry channel in this manner.

## 3-6. EMERGENCY OPERATING PROCEDURE

Emergency operation of the acquisition system will be required under two general conditions. The first of these conditions is the unavailability of data from a source when it normally should be available. This unavailability could be due either to a malfunction of the source equipment or to simple failure to acquire the capsule. The second condition requiring emergency operation is a malfunction of a component, such as a relay, which does not directly affect a data source but which hinders or prevents communication or transmission of data. Procedures for operation under these two general conditions are discussed in the following paragraphs.

### A. OPERATION WITH DATA SOURCE FAILURE

The procedure for operating when data from the normal source is not available is simply to use the next best data which is available. The order of preference of data sources is as follows:

(1). Active acquisition aid in fully automatic tracking.

(2). Active acquisition aid in manual tracking by error signal indication in one channel, automatic tracking in the other.

(3). Active acquisition aid in manual tracking by error signal indications in both channels. (Refer to paragraph 4-2.C.(2).(e).)

(4). Active acquisition aid in manual tracking by means of signal strength indications. (Refer to paragraph 4-2.B.(4).(d).)

(5). Manual input at the acquisition data console.

(6). Independent manual positioning of antennas in accordance with tracking data read over the intercom system. This manner of operation would apply to the transmitting and receiving antennas if their connection to the acquisition bus was broken, but the active acquisition aid was operative and tracking the capsule.

(7). Independent manual positioning of antennas in accordance with predicted data.

### B. OPERATION WITH COMPONENT MALFUNCTION

In many instances if a component fails and cannot be repaired or replaced in the time available, temporary circuit connections can be made which will allow at least limited operation of the system. It is of course impractical to attempt to give specific instructions covering all possible failures; maintenance personnel must have sufficient knowledge of the system to devise temporary fixes on the spot. However, to illustrate the types of fixes that might be used, some examples are given in the following paragraphs.

(1). ACQUISITION DATA CONSOLE 28 VDC POWER SUPPLY

(a). Each of the two 28 VDC power supplies in the acquisition data console is capable of easily supplying all of the current needed in the console and 28-volt devices connected to it. Therefore, failure of one supply reduces the reliability of the console, but does not make it inoperative.

(b). Should both of the console 28-volt supplies fail, 28 VDC can be supplied to the console from other, nearby equipment (preferably the communication technician's console): Turn off the dual power supply OFF-ON switch (figure 3-3) and check the console 28 VDC bus to see that it is not shorted to ground. Jumper any convenient terminal on the console 28 VDC bus (see figure 7-1) to a source in other equipment which can supply about one ampere in addition to its normal load. (The communication technician's console 28 VDC supply easily meets this requirement.) Also connect a jumper between acquisition data console ground and the negative side of the external 28-volt supply. The acquisition data console can now be operated normally except for turning 28 VDC off and on.

(2). RELAYS

Defective relays can be "fixed" by jumpering the normally open terminals. For instance, should the acquisition data console relay (K3) which connects data from the active acquisition aid to the acquisition bus fail, data from the active acquisition aid can be connected to the bus by placing jumpers between terminal boards TB6005 and TB6006. (See figure 7-1.)

(3). <u>SYNCHROS</u>

A defective synchro in a critical place can be replaced by another synchro from a less critical place. For example, if the azimuth or elevation manual input synchro receiver fails, it can be replaced by the receiving or transmitting antenna azimuth or elevation display synchro receiver on the console.

# SECTION IV
# THEORY OF OPERATION

## 4-1. GENERAL

With the exception of the acquisition data console, which is treated in detail, this section presents the theory of operation of the acquisition system on a block diagram level. Adjoining systems, those which receive information from or supply information to the acquisition system, are treated only to the extent of their interconnections with the acquisition system. For further information of these systems, see the applicable system manuals. For detailed information on the components of the acquisition system which are described only on a block diagram level, see the applicable equipment manuals. These manuals are listed in table 1-II.

### A. FUNCTION OF THE SYSTEM

As was described in Section I, the function of the acquisition system is to take the best data available on the capsule's azimuth and elevation at any given time and make it available on the acquisition bus for use by the active acquisition aid, the receiving antenna, and the transmitting antenna. (The acquisition bus is the "common" line which distributes data to the using equipment.) The active acquisition aid uses the data from the acquisition bus as an aid in acquiring the capsule for automatic tracking. As soon as it begins automatic tracking, data from the active acquisition aid is put onto the acquisition bus. The receiving and transmitting antennas and their associated equipment cannot track a target automatically. Therefore, these antennas are normally slaved to data from the acquisition system at all times during a capsule pass.

### B. DATA INPUTS

Data inputs to the acquisition system are available from two sources: manual input and the active acquisition aid. At the acquisition data console, data from the better (more accurate) of these two sources is switched onto the acquisition bus and thereby made available to all of the steerable antennas on the site (except the active acquisition aid if it is the source of the data on the bus).

(1). The manual input to the acquisition system is made with synchro transmitters on the acquisition data console. These synchros are positioned by means of handwheels in accordance with predicted capsule azimuth and elevation data based on computations of the capsule's orbit.

(2). Acquisition data from the active acquisition aid is taken from synchro transmitters which are mechanically coupled to the active acquisition aid antenna; this data is transmitted to the acquisition data console.

C. NORMAL OPERATION

The following is a description of the normal sequence of availability, distribution, and use of acquisition information during a typical pass of the capsule. This description is given as an aid in understanding the overall operation of the acquisition system. It should be noted that several variations from the normal sequence are possible. These variations are discussed in the following description, but should be apparent once the capabilities of the system are understood.

(1). Prior to the pass, predicted target position coordinates — azimuth, elevation, range, and time — are sent to the site in plain text from Goddard Space Flight Center. Coordinates for five different times along the orbit are sent: time of arrival at 700 nautical miles range, 30 seconds later, 60 seconds later, 90 seconds later, and time for position just past zenith when a zenith pass of the capsule is expected. The first set of coordinates is read over the intercom to the acquisition data console operator who sets the manual input synchros accordingly and puts this data on the acquisition bus. The active acquisition aid, transmitting, and receiving antennas are slaved to the manual input. If acquisition (automatic tracking) of the capsule is not accomplished at the time specified by the first set of predicted coordinates, the next three of the remaining sets of coordinates are read and set into the system at the times given. The coordinates just past zenith are used as an aid in re-acquiring the capsule if automatic tracking is lost as it passes overhead.

(2). The active acquisition aid acquires the capsule, and data from the active acquisition aid is put onto the acquisition bus by the acquisition data console operator. The active acquisition aid is no longer slaved to the bus (as it is the source of the data on the bus). However, the other antennas at the site remain slaved to the bus. These conditions — the active acquisition aid tracking automatically and the receiving and transmitting antennas slaved to the acquisition bus — are optimum for the remainder of the capsule pass. They are continued until the capsule is out of range.

## 4-2. DETAILED DISCUSSION

### A. DISCUSSION OF OVERALL SYSTEM

This paragraph discusses the complete acquisition system on a block diagram level (see figures 4-1 and 4-2). Paragraph 4-2. B. and subsequent paragraphs discuss individual components and subsystems of the acquisition system.

(1). On the acquisition data console at the data source selector, which in actuality consists of several relays and switches, azimuth and elevation data from one of the two possible sources is put onto the acquisition bus. (The acquisition bus is indicated by the heavy lines on figure 4-1.)

(2). From the acquisition data console, data goes to the active acquisition aid, to the receiving antenna, and to the transmitting antenna.

(a). The active acquisition aid does not use the data on the acquisition bus when it is tracking the capsule automatically. However, when it is not tracking automatically, the active acquisition aid can usually be slaved to the data on the bus.

(b). The receiving and transmitting antennas are normally slaved to the data on the bus at all times during a capsule pass.

(3). Position and display data from the manual input and the active acquisition aid and display data only from the transmitting and receiving antennas are fed to the acquisition data console. The manual input comprises two synchro transmitters which are positioned by handwheels; one transmitter and handwheel for azimuth data and one for elevation data. The output of the transmitters goes to the data source selector and to synchro displays.

(4). The active acquisition aid puts out azimuth and elevation position data and azimuth and elevation display data. These outputs come from four synchro transmitters, two for position data and two for display data, whose rotors are mechanically coupled to the active acquisition aid antenna. Both position and display data are fed to the acquisition data console. (See figure 7-6.) The position data is routed to the data source selector where it can be put onto the acquisition bus, and the display data goes to the synchro receiver displays for monitoring.

(5). Display data from the receiving antenna is fed directly to synchro

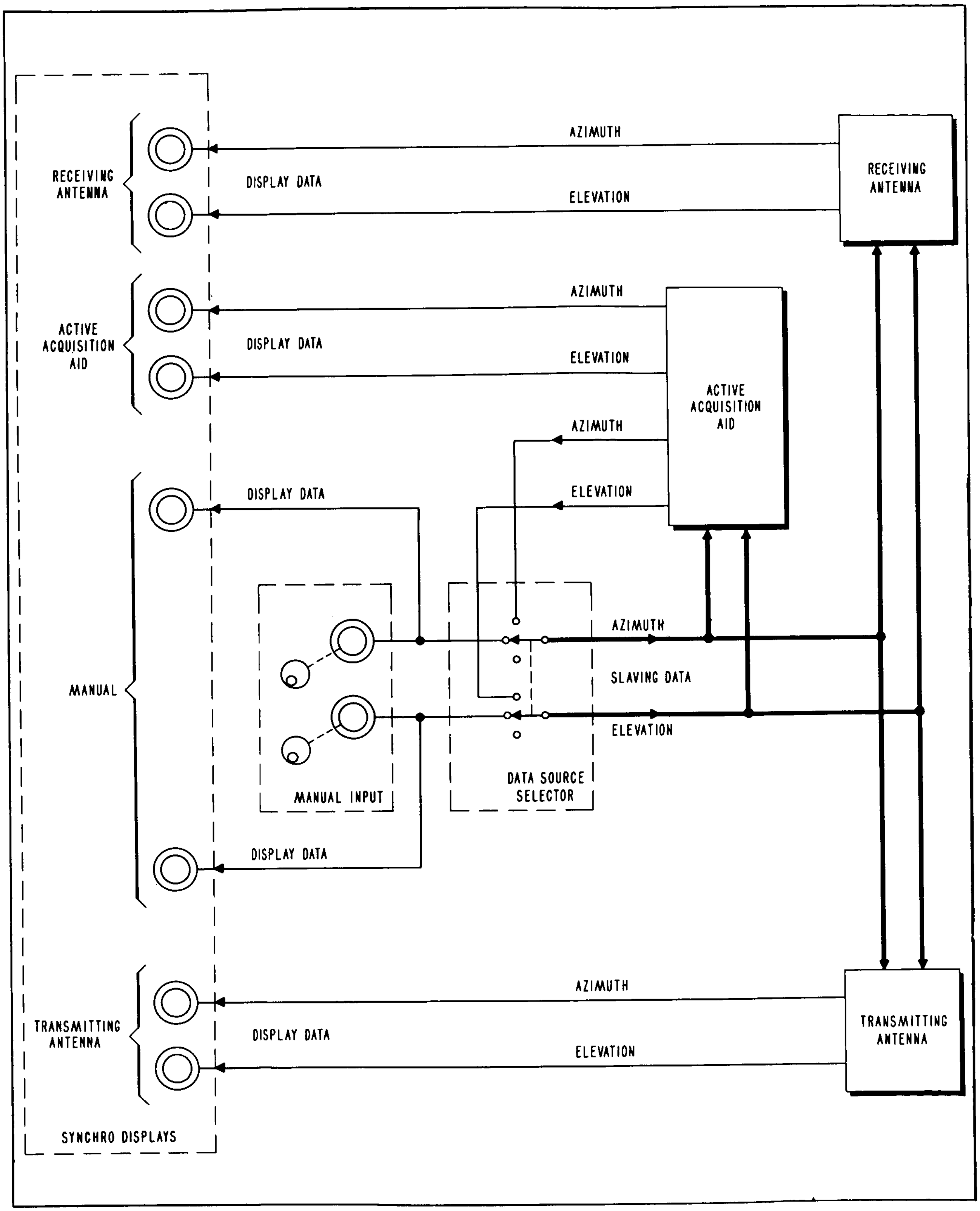



Figure 4-1. Acquisition System, Block Diagram

displays on the acquisition data console. These displays are used for monitoring the operation of the receiving antenna.

(6). As in the case of the receiving antenna, display data from the transmitting antenna is fed directly to acquisition data console synchro displays, where it is used for monitoring.

(7). D-c indications of equipment operating mode and of other information are used in the acquisition system. These indications permit the system operators to monitor the status of the various pieces of equipment, and especially they provide the acquisition data console operator with information he needs to control and direct the operation of the system. Five d-c indications come from the active acquisition aid to the acquisition data console. (See figure 4-2.) Two of these are cable wrap

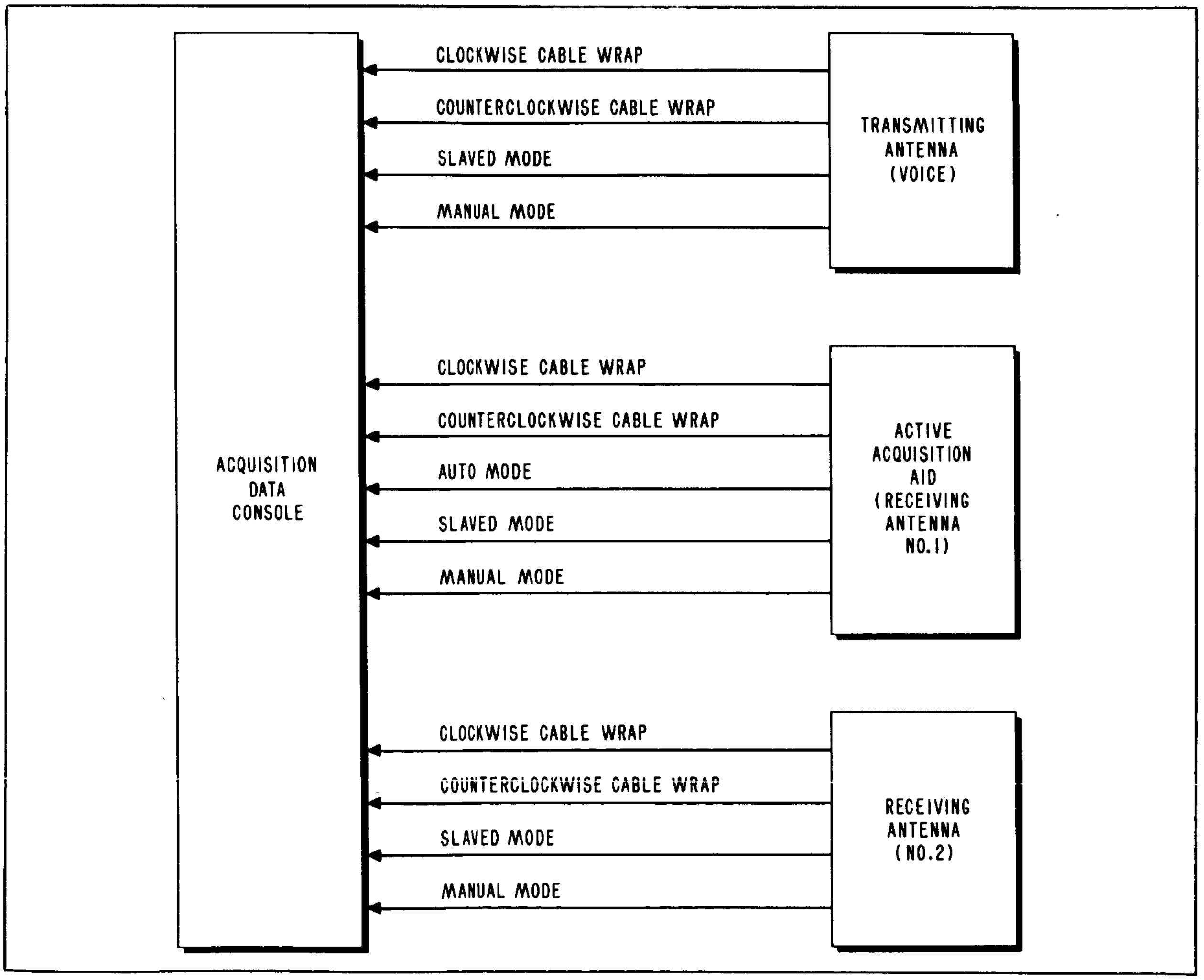



Figure 4-2. Acquisition System D-c Indications, Block Diagram

indications, and three are operating mode indications. The cable wrap indications show which half of its total azimuth travel (540 degrees) the active acquisition aid antenna is in, and when used with the azimuth synchro display from the active acquisition aid permit the acquisition data console operator to tell where the antenna is relative to its azimuth limits. The operating mode indications show whether the active acquisition aid is in its automatic, slaved or manual mode of operation.

(8). The receiving antenna and transmitting antenna each have two cable wrap and two operating mode indications going to the acquisition data console. The cable wrap indications have the same purpose as those from the active acquisition aid. The operating mode indications show whether these antennas are in the slaved or manual mode of operation.

(9). Synchro stator voltages, as shown on figure 401, are transmitted from place to place without voltage transformation. The synchro reference voltages, however, undergo voltage step-up and step-down transformation in order to avoid transmitting relatively large currents over considerable distances. These voltage transformations are shown in simplified form on figure 4-3. Synchro reference voltage of 115 VAC from the power distribution panel is stepped up to 480 VAC for distribution to the equipment in and connected to the acquisition system. A transformer in

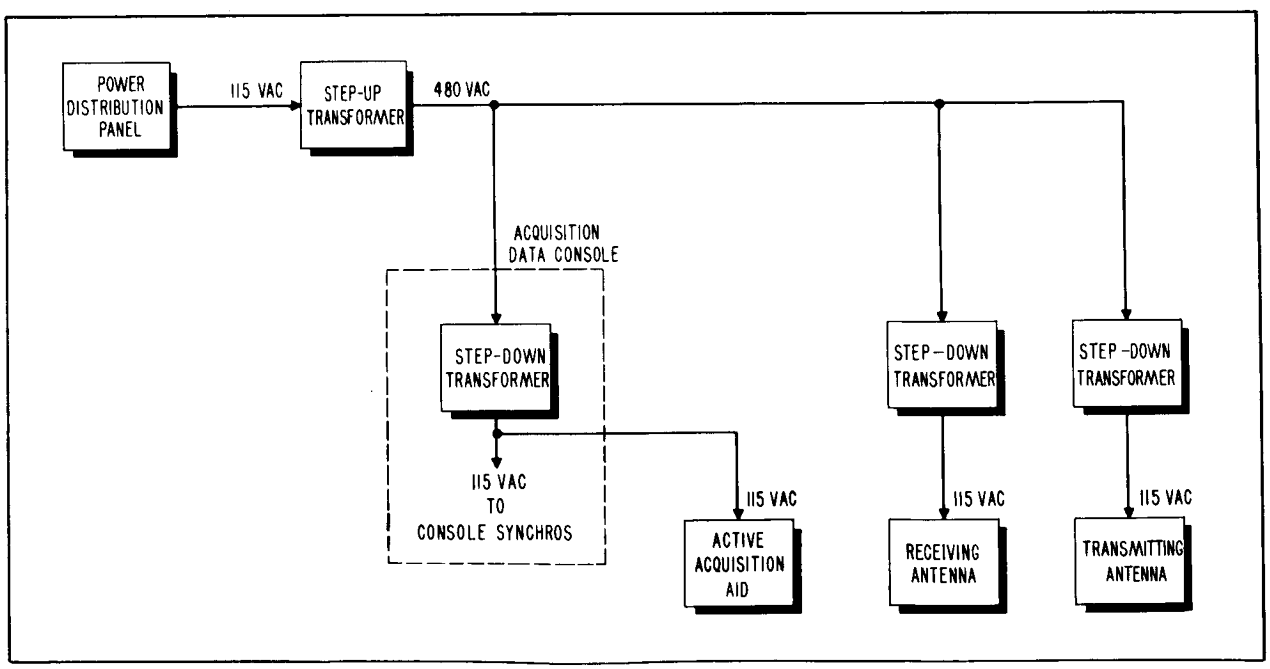



Figure 4-3. Synchro Reference Voltage Transformation and Distribution

the acquisition data console steps the 480 VAC back down to 115 VAC for use by the synchros in the console and the active acquisition aid. For each of the other units in or connected to the acquisition system, a separate transformer steps the 480 volts down to 115 VAC as shown on the illustration. (For an explanation of the nature and purpose of synchro reference and stator voltages, refer to paragraph 4-2. E. (1).

B. ACQUISITION DATA CONSOLE

(1). DUAL POWER SUPPLY

Switches, indicators, and relays on the acquisition data console are energized by 28 VDC from the console 28 VDC supply, which physically consists of the relay chassis, two switches on the acquisition data panel, and the dual power supply. The dual power supply consists of four chassis (two power supply units and two filter units) and a front panel. (See figure 7-3.) Primary power, 115 VAC, is applied through jacks J6201 and J6202 to off-on switch S6201. When switch S6201 is closed, primary power is applied through fuses F6201 through F6204 to the primaries of power transformers T6201 and T6202. The fuses are in indicating-type holders; when a fuse blows, a neon bulb in parallel with the fuse is lit. A neon, power-on indicating lamp, DS6201, is across the line going to power supply unit PS6201. Power supply unit PS6201 and filter unit FL6201 make up power supply number 1; it is a conventional d-c power supply with silicon rectifiers in a bridge configuration and with an LC filter. Note that there is a fuse, F6205, on the d-c side of the power supply. This fuse is not in an indicating-type holder. Power supply unit PS6202 and filter unit FL6202 make up power supply number 2, a second d-c power supply which is identical to the first. The secondaries of power transformers T6201 and T6202 have multiple taps to allow adjustment of the output voltage of the power supplies. The voltage difference between terminals 1 and 2 is 1.5 VAC and is 3 VAC between terminals 3 and 4, 4 and 5, and 5 and 6. Thus, by connecting the a-c leads to the rectifier to different taps on the transformer, the a-c input to the rectifier can be varied over a range of 10.5 volts (rms), and the d-c output of the power supply over a range of approximately 14.5 volts.

(2). POWER SUPPLY CONTROL CIRCUITS

The control circuits for the console power supply are shown on figure 4-4. Each of the blocks on figure 4-4 labeled "28 VDC POWER SUPPLY" represents half of the dual power supply discussed in the previous paragraph and shown on figure

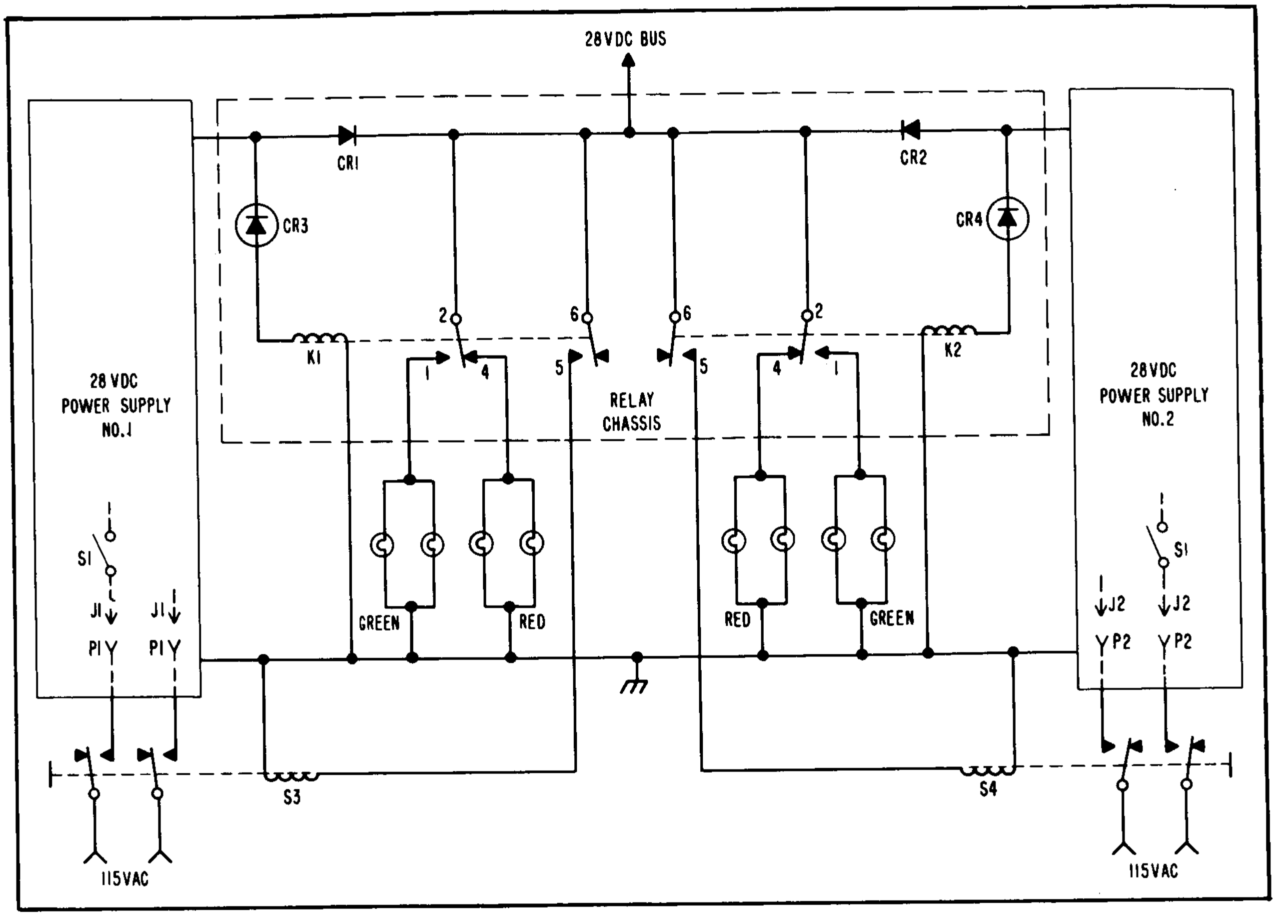



Figure 4-4. Power Supply Control Circuit, Simplified Schematic Diagram

7-3. Switches S6003 and S6004 and the indicator lamps are on acquisition data panel number 2; the rest of the components of the control circuits are on the relay chassis (mounted on the side of the console, near the acquisition data panel).

(a). When switch S6201 on the dual power supply is closed (see figure 7-3), power is applied to power supply number 1 in the dual power supply through manually operated pushbutton switch S6003. The power supply puts 28 VDC on the bus, and relay K6001 is energized. Power is applied through K6001 contacts 5 and 6 to the coil of switch S6003, thus holding switch S6003 closed and keeping the power supply on. With relay K6001 energized, power is applied through K6001 contacts 1 and 2 to the green indicator lamps, which indicate that the power supply is on and operating properly. If power supply number 2 of the dual power supply has not yet been turned on, 28 VDC from power supply number 1 through relay K6002 contacts 2 and 4 lights the red indicator lamps associated with power supply number 2, indicating that it is not on. Rectifier CR6002 prevents current from power supply number 1 from circulating through power supply number 2 and from energizing relay K6002 when power supply number 2 is not on.

**Note**

> The indicator lamps associated with power supply number 1 are in the same physical unit as switch S6003; the lamps associated with power supply number 2 are in the same physical unit as switch S6004.

(b). Zener diode CR6003 in series with the coil of relay K6001 provides a sharp pull-in and drop-out of relay K6001 as the voltage output of power supply number 1 increases or decreases. This action prevents the output of power supply number 1 from being applied to the console 28 VDC bus until it reaches operating value, and in the case of a malfunction resulting in low voltage, disconnects the power supply from the bus. When power supply number 1 is turned on, its voltage output begins to rise. Until the output reaches 18 volts, the resistance of CR6003 is very high, and virtually no current flows through CR6003 and the coil of K6001. As the power supply output increases above 18 volts, the resistance of CR6003 decreases, and rapidly increasing current flows through CR6003 and K6001. (The distinguishing characteristic of zener diodes is that with applied voltages above the diode reference value, 18 volts in this case, and below the maximum rated value, the resistance of the diode varies inversely with the applied voltage; current through the diode varies greatly, but the voltage drop across it remains practically constant. The action of the diode is thus like that of a VR tube. When the supply voltage reaches approximately 22.5 volts, sufficient current flows (4.5 milliamperes) to energize relay K6001. Since the resistance of the relay coil is 1000 ohms, the values of voltage and current in the circuit at this point are as follows:

| | |
|---|---|
| Total applied voltage . . . . . . . . . . . . | 22.5 VDC |
| Voltage drop across CR6003 . . . . . . . . | 18 VDC |
| Voltage drop across K6001 coil . . . . . . . | 4.5 VDC |
| Current $\left(\frac{4.5}{1000}\right)$ . . . . . . . . . . . . . . . | 4.5 MA |

As the power supply output continues to increase, the voltage drop across CR6003 remains at approximately 18 volts, the current through the circuit increases to about 10 milliamperes, and the voltage drop across the K6001 coil increases to about 10 volts.

(c). If a malfunction develops such that the output voltage of power supply number 1 begins to drop, relay K6001 will drop out sharply at an output voltage of about 22.5 volts. This action is due to the sharp increase in the resistance of zener diode CR6003 as the voltage across it drops to 18 volts. (As explained in the previous paragraph, with an output from the power supply of 22.5 volts, 4.5 volts appear across the coil of relay K6001, and 18 volts across diode CR6003.) Blocking diode CR6001 prevents current from power supply number 2 from flowing through diode CR6003 and relay K6001. When relay K6001 is de-energized, the holding coil circuit of switch S6003 is opened (by the opening of K6001 contacts 5 and 6), and primary power is disconnected from power supply number 1.

**Note**

In the preceding and following discussions the values of voltage, current and resistance given are for purposes of explanation. Actual circuit values vary slightly from those given. For instance, 4.5 milliamperes is the maximum current (per manufacturer's data) which is required for pull-in of relays of the type employed in the control circuit (K6001). The pull-in current for individual relays, however, varies downward from this value. Also, the dropout current of any individual relay is, of course, less than the pull-in current. Hence relay K6001 may be expected to pull in at a total applied voltage somewhat less than 22.5 VDC and to drop out at a still lower voltage.

(d). The action of the control circuit of power supply number 2 is identical to that of the control circuit of power supply number 1.

(e). A summary of the action of the power supply control circuits is as follows:

1. Switch S6003 is manually closed, and primary power is applied to power supply number 1 (assuming that switch S6201 on the dual power supply has been closed).

2. Power supply number 1 puts 28 VDC on the bus, energizing relay K6001 and lighting the red indicator lamps in the control circuit of power supply number 2.

3. Relay K6001 closes, lighting the green indicator lamp associated with power supply number 1 and applying power to the holding coil of switch S6003.

4. Switch S6003 remains closed, and power supply number 1 is in operation.

5. Switch S6004 is closed, and primary power is applied to power supply number 2.

6. Power supply number 2 puts 28 VDC on the bus, in parallel with the power from power supply number 1.

7. Relay K6002 is energized, turning off the red indicator lamps associated with power supply number 2 and lighting the green indicator lamps. Power is applied through K6002 contacts to the holding coil of switch S6004, holding S6004 in the on position. Both power supplies are now in operation.

8. Both power supplies are turned off by opening switch S6201 on the dual power supply.

9. If the voltage output of one of the power supplies drops to approximately 22.5 volts, the control relay (K6001 or K6002)

associated with the malfunctioning power supply is de-energized and the primary power to that power supply is removed. Power from the other power supply lights the red indicator lamps of the malfunctioning supply. The ratings of the power supplies are such that one of them can supply all of the power required by the console in the event of the failure of the other.

(3). SWITCHES AND INDICATORS

(a). A number of switch assemblies and indicator assemblies are used on the acquisition data panels of the acquisition data console. An exploded view of the type of switch assembly used is shown in figure 4-5. The assembly consists of two main detachable sections: the switch and the operator-indicator unit with coil. The switch has up to four single-pole, double throw sections. All of the switch sections are actuated simultaneously by a plunger in the operator-indicator unit. The operator-indicator unit has two main, non-detachable sections: the coil and the indicator. When energized, the coil holds the plunger in its actuated position. The indicator has four lamp sockets, lamps, color filters, and a three-piece display screen. The lamps are white, so the colored lighting of the indicator is obtained by the use of filters which fit over the lamps. The display screen snaps into the end of the indicator plunger when the indicator is assembled, so that the plunger is moved and the switch actuated by depressing the display screen.

(b). The indicator assemblies used on the console are like the operator-indicator unit shown on figure 4-5, except that the indicator assemblies have no coil and no plunger.

(4). CIRCUIT DESCRIPTION (Figure 7-1)

This paragraph gives a detailed description of the circuits of the acquisition data console except for the power supply, which is described in a previous paragraph.

(a). DC INDICATIONS

The operating modes of the active acquisition aid and the transmitting and receiving antennas are indicated by lamps on the

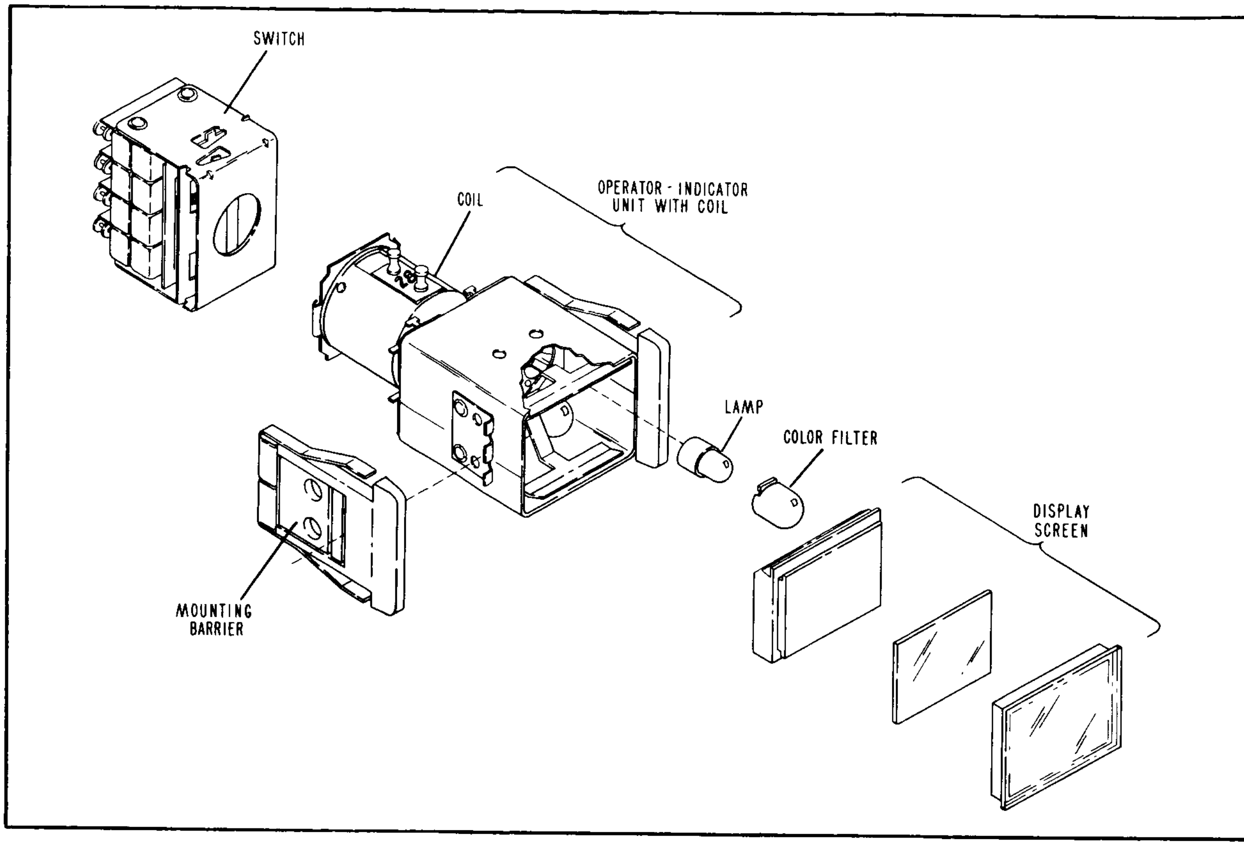



Figure 4-5. Switch Assembly, Exploded View

acquisition data console. These lamps are supplied with ground at the acquisition data console. Twenty-eight volts dc is supplied through switches in external equipment; for instance, when the active acquisition aid operator closes a switch which connects 28 VDC to terminal 8 of terminal board TB6002 in the console, thus lighting active acquisition aid "AUTO" indicators DS6011 and DS6012. Other operating mode indicators on the console are as follows:

1. Manual tracking by the active acquisition aid is indicated by the lighting of active acquisition aid "MANUAL" indicators DS6015 and DS6016 by applying 28 VDC through the active acquisition aid mode switch and terminal 3 of TB6002. The slaved mode is shown by indicators DS6013 and DS6014. Twenty-eight volts d-c is applied to these indicators through the active acquisition aid mode switch and terminal 1 of TB6002.

2. The two channels, azimuth and elevation, of the active acquisition aid antenna drive system are independent of one another to the extent that either channel can be operated in the automatic, manual, or slaved mode while the other channel is operated in another mode. The "AUTO" (mode) switches (S68301 and S68302) of the antenna are connected to the "AUTO" indicators in the acquisition data console in such a manner that when either channel is operating in the automatic mode, an "AUTO" indication is given on the acquisition data console. The "LOCAL-REMOTE" (mode) switches (S101 and S102) are connected to the "MANUAL" and "SLAVED" indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified form on figure 4-6. The complete interconnecting circuit is shown on figure 7-11.

3. The active acquisition aid antenna can rotate 540 degrees in azimuth from its clockwise to its counterclockwise limit. Since it can rotate more than 360 degrees, there are azimuths at which the synchro display alone is ambiguous; i.e., the synchro display shows the azimuth of the antenna, but does not show whether it is on its first or second time around. Since the antenna cannot rotate continuously, it is necessary to know where it is relative to its limits of rotation so that the operator can position it for maximum freedom of rotation in either direction and can avoid driving it into its limit stops. The ambiguity of the synchro display is resolved by the use of "CABLE WRAP" indicator lamps DS6005 and DS6006 which are lit by the closing of a switch on the antenna pedestal. This switch is so located that it is actuated when the antenna passes the mid-point between its azimuth limits. The DS6005 circuit is closed by the switch and the

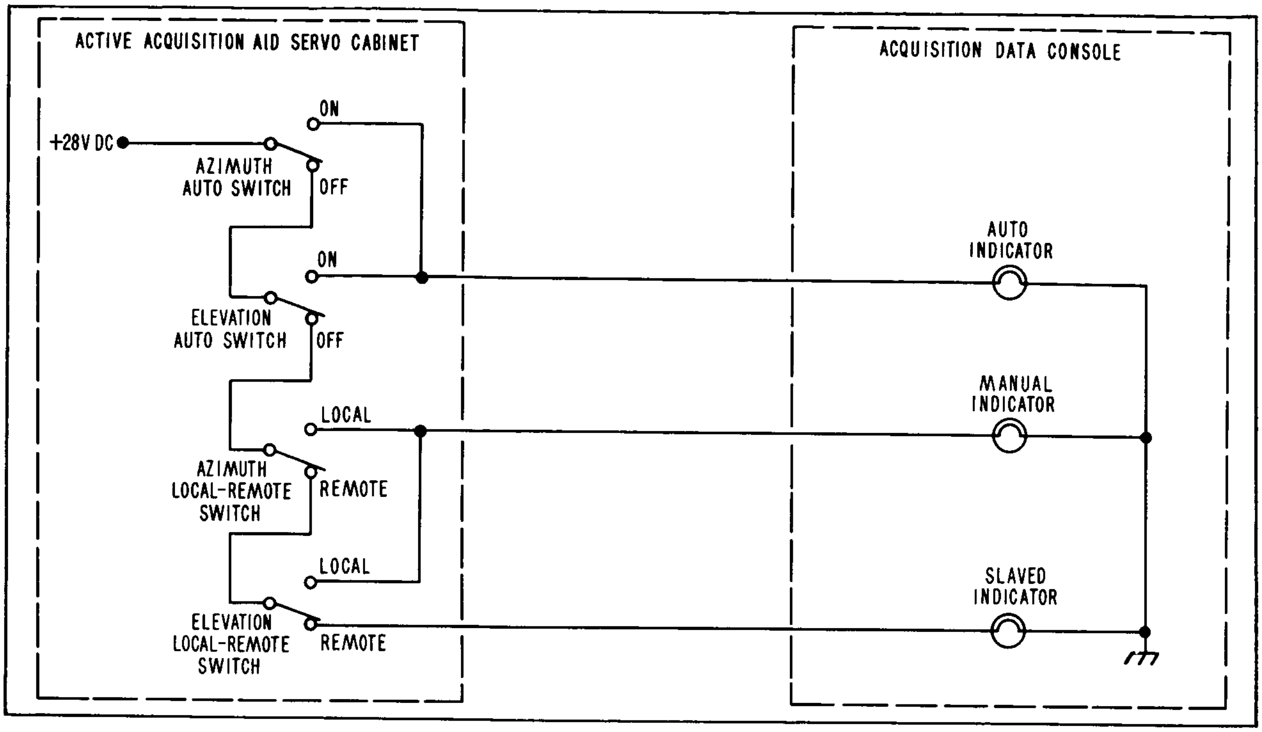



**Figure 4-6. Active Acquisition Aid Antenna Mode Indication Circuit, Simplified Schematic Diagram**

DS6006 circuit is opened when the antenna is rotating clockwise (looking at it from above); the DS6006 circuit is closed and the DS6005 circuit opened when the antenna is rotating counter-clockwise. At installation, the antenna is so oriented that the counterclockwise limit is reached at zero degrees (relative to north) and the clockwise limit at 180 degrees. (See figure 4-7.) With this orientation, the cable wrap indicator switching occurs at 270 degrees. Figure 4-8 illustrates how the cable wrap indicator lamps and the antenna azimuth display synchro together show the acquisition data console operator where the antenna is relative to the limits of rotation. When the upper cable wrap indicator is lit (figures 4-8(A) and 4-8(B)), the antenna has been turned past 270 degrees azimuth in a clockwise direction, and if it continues in a clockwise direction, the limit of rotation will be reached at 180 degrees azimuth. When the lower indicator is lit (figures 4-8(C) and 4-8(D)), the antenna has been turned

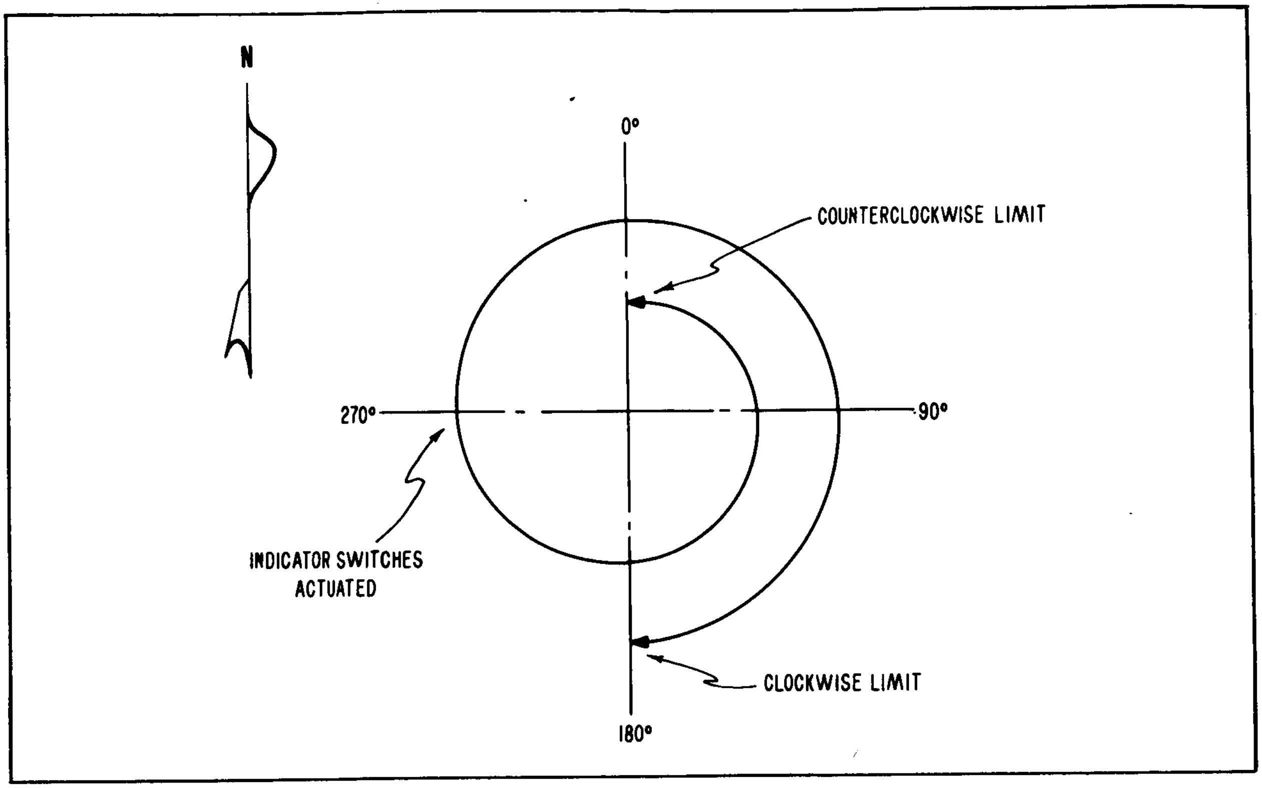



Figure 4-7. Diagram of Antenna Cable Wrap Limits

past 270 degrees in a counterclockwise direction, and continuing in a counterclockwise direction the limit will be reached at zero degrees. Thus, as long as the synchro pointer is on the half of the dial (upper or lower) which is the nearer to the lighted indicator (figures 4-8(A) and 4-8(C)), there is no limit problem and the antenna can safely be turned in either direction; when the synchro pointer is on the half of the dial opposite the lighted indicator (figures 4-8(B) and 4-8(D)), the antenna is near one of its limits of rotation and care must be exercised not to drive it into the limit stop. The complete circuit of the active acquisition aid cable wrap indicators is shown in figure 7-11. Note that the indicators on the acquisition data console are electrically independent of the indicators on the active acquisition aid servo cabinet.

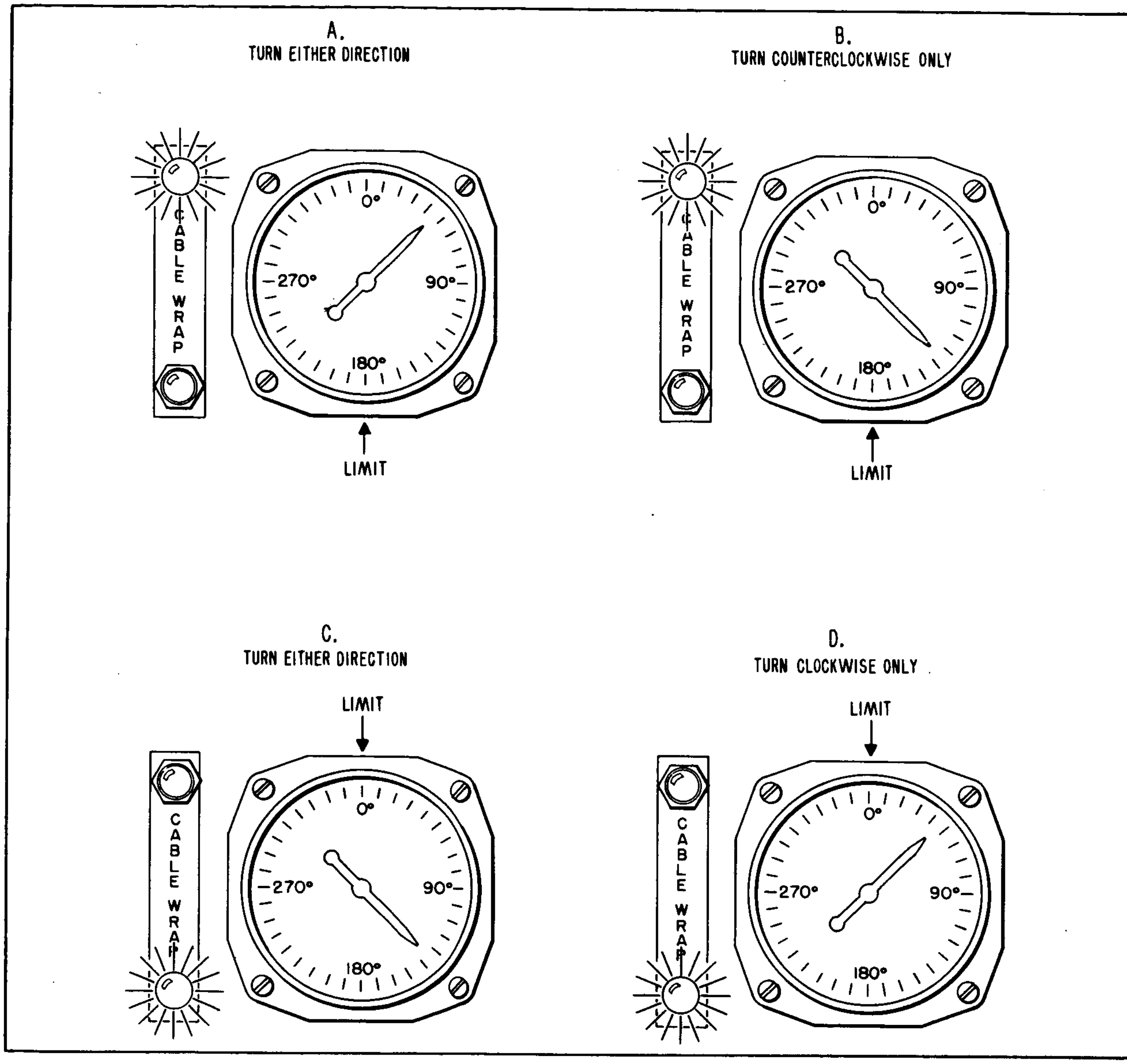



Figure 4-8. Synchro and Lamp Indications of Antenna Bearing Relative to Cable Wrap Limits

4. The operating mode of the receiving antenna is indicated by "SLAVED" indicators DS6017 and DS6018 and "MANUAL" indicators DS6019 and DS6020. Twenty-eight volts d-c is applied to these indicators by the receiving antenna mode ("LOCAL-REMOTE") switches (S101 and S102) on the receiving antenna servo cabinet through terminal board TB6003, terminals 1 and 3. "CABLE WRAP" indicators DS6007 and DS6008 are operated in

the same manner as the cable wrap indicators for the active acquisition aid described above. (See figure 7-12 and compare it with figure 7-11.)

5. The two channels, azimuth and elevation, of the receiving antenna drive system are independent of one another to the extent that either channel can be operated in the slaved or manual mode while the other channel is operated in the other mode. The "LOCAL-REMOTE" (mode) switches (S101 and S102) of the antenna are connected to the operating mode indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified for on figure 4-9. From the illustration it can be seen that when both the azimuth and elevation "LOCAL-REMOTE" switches are in 'REMOTE" (slaved) position, 28 VDC is applied to the "SLAVED" indicator on the acquisition data console; when either "LOCAL-REMOTE" switch is in the "LOCAL" (manual) position, 28 VDC is applied

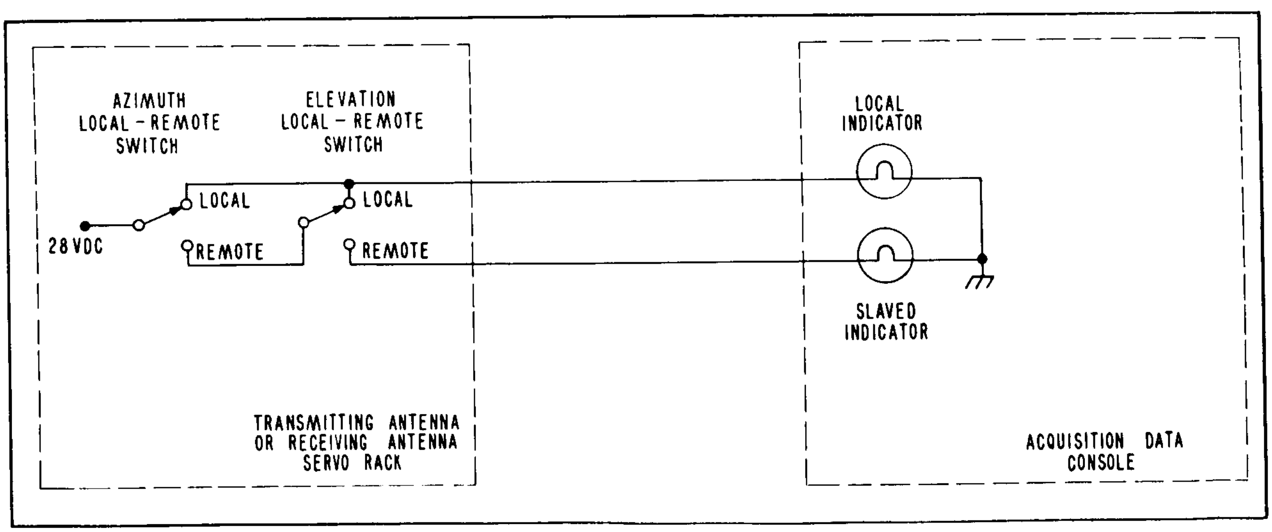



Figure 4-9. Transmitting and Receiving Antenna Mode Indication Circuit, Simplified Schematic Diagram

to the "MANUAL" indicator on the console. The complete circuit which provides these indications is shown on figure 7-12.

6. The transmitting antenna operating mode is indicated by "SLAVED" indicators DS6021 and DS6022 and "MANUAL" indicators DS6023 and DS6024. "CABLE WRAP" indicators DS6009 and DS6010 are operated in the same manner as the cable wrap indicators for the active acquisition aid. (See figure 7-12 and compare it with figure 7-11.) The transmitting antenna "LOCAL-REMOTE" (mode) switches (S101 and S102) are connected in the same manner as those of the receiving antenna: when both channels of the transmitting antenna drive system are in "REMOTE" (slaved), a "SLAVED" indication appears on the acquisition data console; when either one or both channels are in "LOCAL" (manual), a "MANUAL" indication is given on the acquisition data console. See figures 4-9 and 7-12.

(b). SYNCHRO CIRCUITS (Figure 7-1)

There are four pairs of synchro receivers and one pair of synchro transmitters on the acquisition data console. (For a description of the principles of operation of synchros, refer to paragraph 4-2. E.) One of each pair handles azimuth data and the other elevation data. (See figure 7-1.)

1. Display data from the active acquisition aid is displayed by synchro receivers B6001 and B6002. Azimuth display data comes into the console by way of terminal board TB6008 to synchro receiver B6001, and elevation data comes in by way of terminal board TB6008 to receiver B6002. Active acquisition aid position data comes into terminal board TB6005 and thence to the contacts of relay K6003, where it is available for switching onto the acquisition bus. As shown on figure 7-6, the position data from the active acquisition aid comes from synchro transmitters B202 and B302, and the display data comes from synchro transmitters B204 and B304 in the active acquisition aid pedestal. The acquisition bus from the acquisition data

console is connected to the azimuth and elevation "LOCAL-REMOTE" switches S102 and S101 in the active acquisition aid servo cabinet. When these switches are in the remote position, the slaving data from the acquisition bus is connected to control transformers B203 (azimuth) and B303 (elevation) for slaving the active acquisition aid antenna.

2. Display data from the receiving antenna comes into the console by way of terminal board TB6011 and is displayed by azimuth synchro receiver B6003 and elevation synchro receiver B6004. As shown on figure 7-8, the display data comes from synchro transmitter B202 (azimuth) and B302 (elevation) on the receiving antenna pedestal. The acquisition bus from the acquisition data console is connected to the azimuth and elevation "LOCAL-REMOTE" switches S102 and S101 in the receiving antenna servo rack. When these switches are in the remote position, slaving data from the acquisition bus is connected to control transformers B203 (azimuth) and B303 (elevation) for slaving the receiving antenna.

3. Display data from the transmitting antenna comes into the console by way of terminal board TB6012 and is displayed by azimuth synchro receiver B6005 and elevation synchro receiver B6006. As can be seen by a comparison of figures 7-9 and 7-8, the internal synchro circuits of the transmitting antenna are identical to those of the receiving antenna, described in the previous paragraph.

4. The manual input to the acquisition bus is made by means of synchro transmitters B6009 and B6010 — B6009 for azimuth data and B6010 for elevation data. (See figure 7-1.) The output of these synchro transmitters is available at relay K6004 for switching onto the acquisition bus and is also wired directly to manual display synchro receivers B6007 (azimuth) and B6008 (elevation). Note that the S1–S3 connections from the manual synchro transmitters to the manual display receivers and to the

acquisition bus are reversed. This reversed connection is necessary to obtain the proper output from the manual synchro transmitters because of a direction reversal that occurs in the gearing between the transmitter handwheels and the transmitters. To set data into the manual synchro transmitters, the console operator turns the transmitter handwheels and observes the manual receiver displays. There are no dials on the handwheels or the transmitters themselves to indicate the position of the transmitters.

5. Reference voltage for all of the synchros on the console is supplied from transformer T6001. Note that the synchro reference voltage circuit is separate from the 115 VAC which provides primary power for the console 28 VDC power supply.

(c). DATA SWITCHING

The switching of data onto the acquisition bus from one of the two available sources (manual input and active acquisition aid) is controlled by switches S6001 and S6002 (figure 7-1). These switches (and switches S6003 and S6004 associated with the 28 VDC power supply) are switch assemblies of the type described in paragraph 4-2. B. (3) and illustrated in figure 4-5.

1. Switch S6001 is the active acquisition aid "SOURCE" switch. When the plunger of S6001 is depressed, 28 VDC from the console d-c bus is applied through the common and normally-open contacts of section S6001A to the switch holding coil and to indicator lamps DS6025 and DS6026. The lamps are lit, and the holding coil, which is grounded through the common and normally-closed contacts of section C of switch S6002, is energized. The action of the coil holds the plunger of S6001 in its depressed position. The common and normally-closed contacts of section S6001A are in the series with the 28 VDC supply to switch S6002; thus, when the plunger of S6001 is depressed, the 28 VDC supply to S6002 is interrupted, and if S6002 had been energized, it is now de-energized. With switch S6001 closed (plunger

depressed), 28 VDC is supplied through the common and normally-open contacts of section S6001B to the coil of relay K6003, energizing this relay and connecting position data from the active acquisition aid to the acquisition bus. The connections to the common and normally-closed contacts of section S6001C are not used.

2. Switch S6002 is the manual "SOURCE" switch. Section S6002C is in series with the holding coil of switch S6001; when S6002 is actuated (plunger depressed), the holding coil circuit of S6001 is opened, de-energizing switch S6001 if it had been energized. Twenty-eight volts d-c is applied to the normally-open contact of S6002A and thence to the holding coil of switch S6002 and to indicator lamps DS6027 and DS6028. The 28 VDC applied to the holding coil of S6002 energizes the coil and holds the switch plunger in the actuated position. The indicator lamps are lit, identifying the data source which has been selected. Also when S6002 is actuated, 28 VDC is applied through the common contact to the normally-open contact of section S6002B, and from there to the coil of relay K6004. The voltage on the coil of relay K6004 energizes that relay, and data from the manual input is connected to the acquisition bus.

3. "NO DATA ON BUS" indicator lamps DS6029 and DS6030 are supplied with 28 VDC in series with the common and normally-closed contacts of the A sections of switches S6001 and S6002. The indicator lamps are lit as long as the console 28 VDC power supply is on and neither of the two switches has been actuated; when either of the switches, S6001 and S6002, is actuated, the "NO DATA ON BUS" indicator lamps are out.

4. As described in the preceding paragraphs, switches S6001 and S6002 are electrically interlocked; when one of them is actuated by depressing the plunger, d-c voltage to the other one is interrupted. If both are actuated at the same time (which should never happen), they open each others circuits. In this

condition (two switches simultaneously depressed) only the switch electrically nearer the 28 VDC power supply will put the data from the source associated with it on the acquisition bus. If the two depressed switches are released simultaneously, no data remains on the bus, as both the holding coil circuits are opened. If one switch is released after the other, data associated with that switch will remain on the bus. Hence, the switching circuits on the console are so arranged that data from only one source at a time can be put on the bus.

5. When the dual power supply on the console is first turned on, none of the "SOURCE" switches is actuated. After one of them has been actuated, or turned on, they can both be de-energized, or turned off, only by turning off the dual power supply with switch S6201 (on the front of the dual power supply panel).

(d). SIGNAL STRENGTH AND AUDIO CIRCUITS (Figures 7-1 and 7-14)

1. Signal strength indications from the telemetry equipment on the site come into the acquisition data console on terminal boards TB6007 and TB6009. (A simplified schematic is shown on figure 4-10. The complete circuit of the connections between the telemetry equipment and the console is shown on figure 7-14.) These indications are in the form of d-c voltages whose magnitudes are indicative of the strength of the r-f signal inputs to the telemetry receivers. The d-c indications are applied through calibration potentiometers R6001 through R6004 and series voltage dropping resistors R6005 through R6008 to "SIGNAL STRENGTH" meters M6001 through M6004. The face of these meters is calibrated in microvolts on a non-linear scale. The calibration potentiometers are used to adjust the amount of resistance in the circuits so that with signals of known voltage amplitude applied to the inputs of the telemetry receivers, the signal strength meters indicate that signal magnitude. Hence, after proper calibration, the meters on the console indicate the absolute magnitude of the signal being

received by each of the four telemetry receivers. On the active acquisition aid servo cabinet meter and switch panel there is a fifth signal strength meter, which indicates the strength of the signal in the sum channel of the active acquisition aid. The telemetry receivers and associated equipment (and the console signal strength and audio circuits) are designated by the frequency on which they operate and the antenna from which they receive their signal. The letters "A" and "B" designate frequency, and the numbers "1" and "2" designate the receiving antenna and the active acquisition aid antenna.

2. Audio signals from the site telemetry equipment and the active acquisition aid come into the acquisition data console on terminal boards TB6002, TB6007, and TB6009 and through channel selector switch S6005 into terminal TB1-2 of the console audio amplifier. See figures 4-10 and 7-14. (Refer to paragraph 4-2. D. for information on the audio amplifier.) Switch S6005 selects one of five audio signals for monitoring and except when the audio source is the active acquisition aid, at the same time lights a channel selector indicator lamp next to the "SIGNAL STRENGTH" meter which is associated with the telemetry equipment which is the source of the monitored audio. (There is no pilot lamp associated with the signal strength meter on the active acquisition aid.) The channel selector indicators, DS6001 through DS6004, provide a correlation between monitored audio and signal strength indication. The purpose of monitoring audio is to permit the operator to confirm that a signal strength indication is from an actual telemetry signal and not just noise. As shown by figures 7-1 and 7-14, the audio volume control, R6009, is located on the console outside of the audio amplifier itself. See figure 3-2 for the location of the volume control.

3. For manual tracking by means of received signal strength, the receiver (telemetry or active acquisition aid) is selected

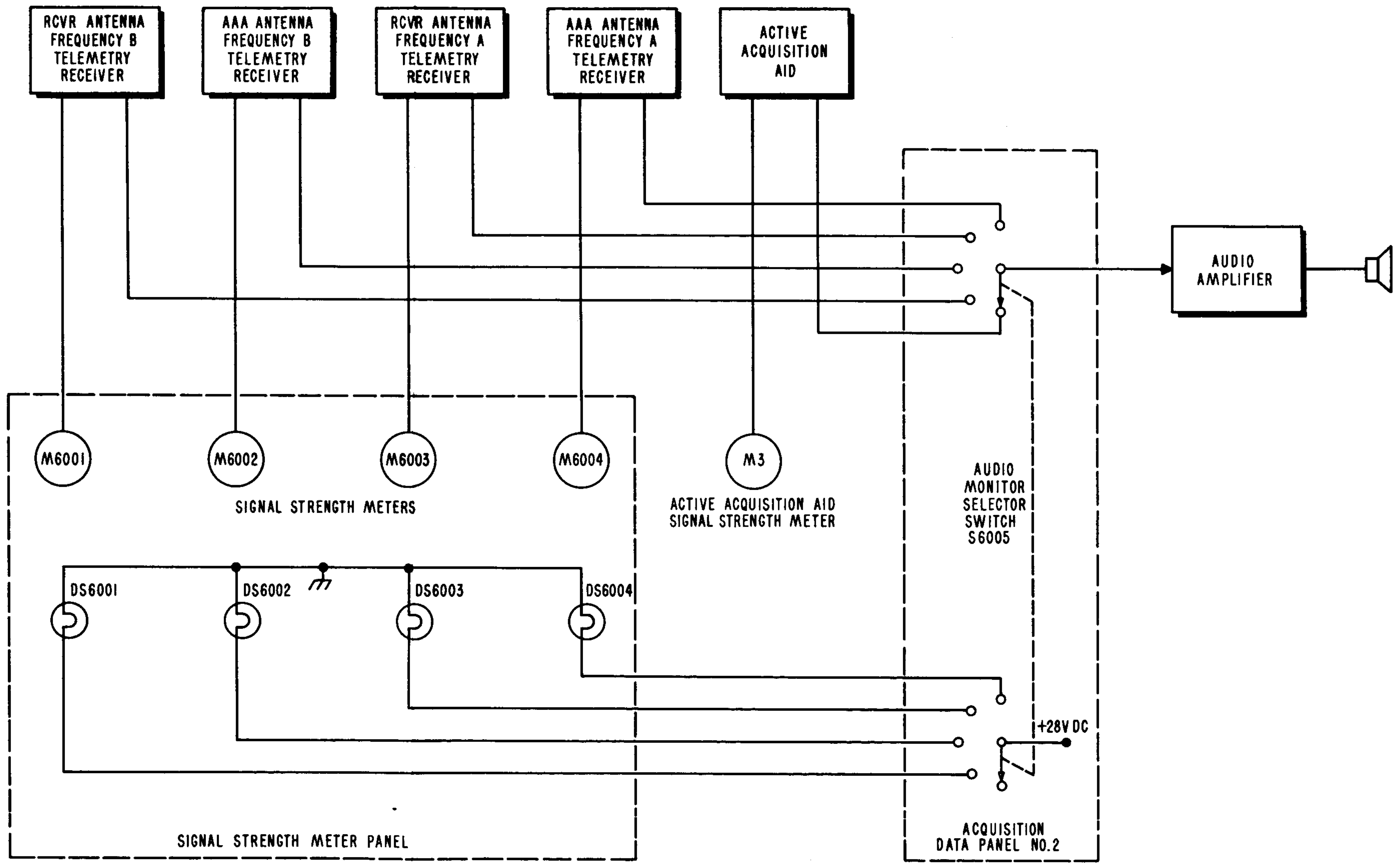



Figure 4-10. Signal Strength Indicating Circuits, Simplified Schematic Diagram

which provides the best signal strength indication and audio. When the selected receiver is the active acquisition aid itself or one of the two telemetry receivers connected to its antenna, the operator simply turns the handwheels on the servo cabinet for maximum signal strength as indicated on the appropriate meter. Monitoring of the audio insures that a telemetry signal and not just noise is being received. When one of the telemetry receivers connected to the receiving antenna is selected, the receiving antenna must be slaved through the acquisition system to the active acquisition aid. Under this condition, the active acquisition aid operator turns the handwheels on the servo cabinet (thereby remotely positioning the receiving antenna) for maximum signal indication from the selected receiver.

C. ACTIVE ACQUISITION AID

(1). GENERAL

(a). The active acquisition aid has a wide antenna pattern (20 degrees) and tracks with an accuracy within 0.5 degree. Because of its wide cone of coverage, the active acquisition aid does not require precise antenna pointing in order to acquire its target, the Mercury capsule. The antenna is pointed in accordance with the best data available. For initial acquisition, as the capsule comes over the radio horizon, this data is based on computations of the capsule's orbit. For re-acquisition in the event automatic tracking is lost during a pass of the capsule, the best data is in most cases simply an estimate based on the capsule's position when the track was lost. As soon as the capsule comes within its 20-degree cone of coverage, the active acquisition aid acquires an automatic track and steers itself to boresight; i.e., it points its antenna so that the capsule is in the center of its cone of coverage. Position data (capsule azimuth and elevation) is then put out by the active acquisition aid and at the acquisition data console is switched onto the acquisition bus.

(b). The primary function of the active acquisition aid is to provide pointing data to the non-tracking antennas on the site. After it acquires the capsule, the active acquisition aid continues automatic tracking until the capsule is out of range. The non-tracking antennas are normally slaved through the acquisition system to the active acquisition aid.

(c). A secondary function of the active acquisition aid is to receive HF voice, UHF voice, and telemetry signals. HF voice signals are received by an HF dipole and reflector which are mounted on the active acquisition aid antenna. The received HF signals are fed directly to an HF voice receiver. Telemetry and UHF voice signals are received by the active acquisition aid quad-helix antenna. UHF voice signals are separated from the telemetry by the triplexer and fed to a UHF voice preamplifier (part of the capsule communications system). The two telemetry frequencies go through two stages of r-f amplification in the active acquisition aid and then are fed out to telemetering system equipment.

(2). <u>BLOCK DIAGRAM DESCRIPTION (Figure 4-11)</u>

(a). The active acquisition aid quad-helix antenna receives two telemetry signals transmitted by the capsule. These signals are fed from the helical antenna elements to an r-f bridge composed of the four hybrid rings. For each frequency, three outputs from the r-f bridge are used. These outputs are a reference signal (vectorial sum of the signals from the four antenna elements), a signal (azimuth error) which depends on the azimuth displacement of the antenna from boresight. The derivation of the azimuth and elevation signals is based on a phase comparison in the r-f bridge of the signals from the antenna elements. When the antenna is off boresight in azimuth, the signals from the two elements on the right side of the antenna differ in phase from the signals from the two elements on the left side; when the antenna is off boresight in elevation, the signals from the two top elements differ in phase from the signals from the two bottom elements. Comparison of these phases yields the error signals.

(b). The azimuth and elevation error signals and the reference signal are fed from the r-f bridge through the triplexer and diplexers,

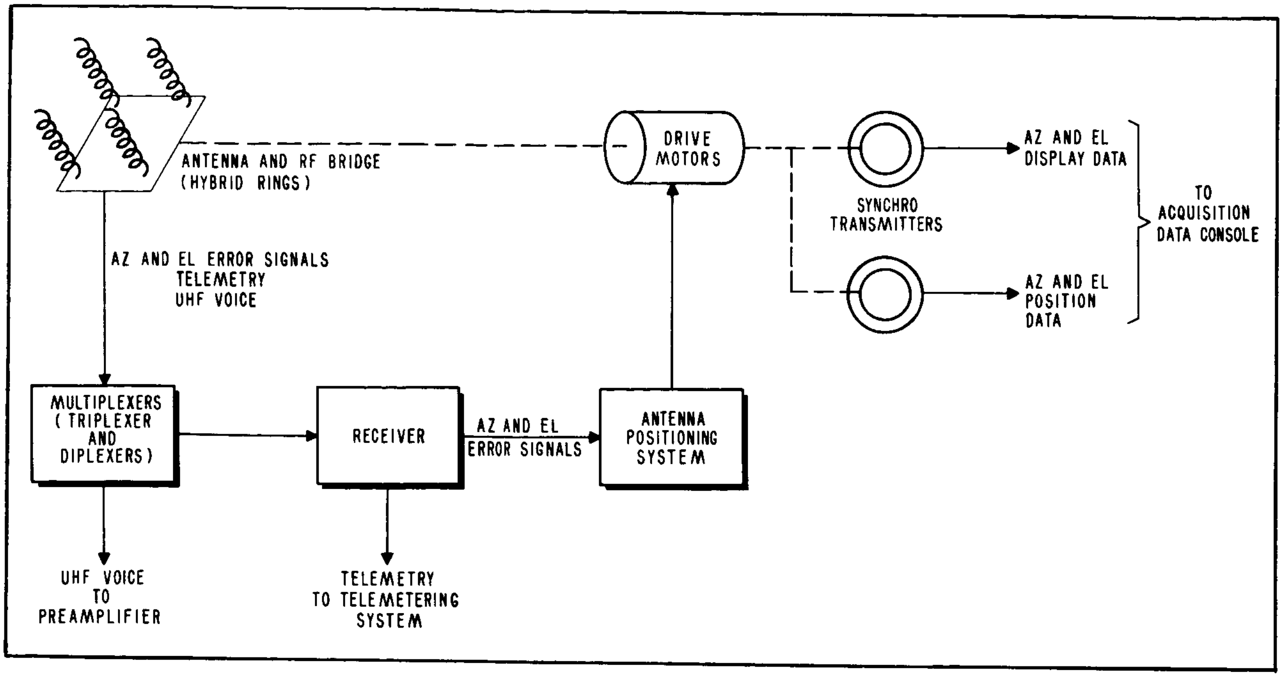



**Figure 4-11.** Active Acquisition Aid, Simplified Block Diagram

for frequency separation, to the receiver. The first and second r-f amplifiers and the first mixer and i-f amplifier of the receiver are in the RF housing unit. The balance of the receiver circuits are in the receiver cabinet. The receiver locks onto one or the other of the telemetry frequencies, as selected by switch.

(c). The output of the receiver consists of azimuth and elevation error signals to the antenna positioning system. The antenna positioning system comprises, in essence, electronic and electro-mechanical servo amplifiers and antenna drive motors. This system continuously positions the antenna for minimum, or null, error signals out of the receiver. Thus, the antenna is kept pointing at the target which is being tracked.

(d). Two pairs of synchro transmitters are mechanically coupled to the antenna. One of these pairs transmits antenna azimuth and elevation position data to the acquisition bus. The other pair transmits azimuth and elevation display data for display on the active acquisition aid servo cabinet and on the acquisition data console. The position data transmitters provide the principal output of the active acquisition aid system; these transmitters are the means by which acquisition and tracking information is sent to other equipment.

(e). On the meter and switch panel of the servo cabinet, there are azimuth and elevation error meters which permit manual tracking with the active acquisition aid in the event that part of the automatic system is inoperative or when it is not desired to use fully automatic tracking. These meters indicate the amount and direction of antenna pointing error. (The errors indicated by the meters are essentially the same as those supplied to the antenna positioning system during fully automatic tracking.) For manual tracking with the error meters the operator simply turns the manual handwheels on the servo cabinet to null the errors indicated on the meters. Also on the meter and switch panel there is a signal strength meter. For a description of its use, refer to paragraph 4-2. B. (4). (d).

D. AUDIO AMPLIFIER

(1). The audio amplifier, which forms part of the acquisition data console, uses conventional circuitry throughout. See figure 7-5. Input signals applied to TB1-2 (the TB1-3 input is not used) are coupled by input transformer T2 to the grid of voltage amplifier V2A. (As shown on figure 7-5, the primary of T2 consists of two series windings, which are connected by a jumper between T2 terminals 3 and 4. This connection provides a 600-ohm input impedance.) The output from the plate of V2A is coupled by capacitor C1 through TB1-6 to volume control potentiometer R6009, which is external to the amplifier. Signals from the volume control are connected through TB1-7 directly to voltage amplifier V2B and thence through coupling capacitor C2 to power amplifier V3. The output of V3 is applied through output transformer T3 either to phone jacks J1 and J2 or to the speaker, LS1, as selected by "SPEAKER ON-OFF" switch S1. When switch S1 is off, terminals 3 and 8 (500-ohm impedance) of T3 are connected to the phone jacks, and terminals 3 and 4 (four-ohm impedance) are connected to resistors R8 and R12. These resistors impose a load on the low impedance winding of the output transformer, in parallel with the high impedance winding connected to the phone jacks.

(2). Primary power for the amplifier is supplied through "AMPLIFIER ON-OFF" switch S2 and fuse F1 to the power supply, which comprises transformer T1, full wave rectifier V1 and a filter network which consists of resistors R9 and R10 and capacitors C5, C6, and C7. Plate supply voltage for the output stage, V3, is taken from the power supply filter at the junction of resistors R9 and R10, and the supply voltage for the plates of V2 and the screen of V3 is taken from the junction of R10 and bleeder R11.

E. SYNCHROS

(1). TRANSMITTERS AND RECEIVERS

(a). A standard synchro transmitter or receiver, such as is used in the acquisition system, may be considered as a single phase transformer with a rotatable primary and a stationary, wye-wound secondary. Accordingly the primary winding is called the rotor, and the secondary windings are called the stator. The two terminals of the rotor windings are designated R1 and R2, and the terminals of the three stator windings are designated S1, S2, and S3.

(b). A reference, or excitation voltage (115 VAC, 60 cycles for the synchros in the acquisition system) is applied to the rotor of a synchro. (See figure 4-12.) This reference voltage applied to the rotor

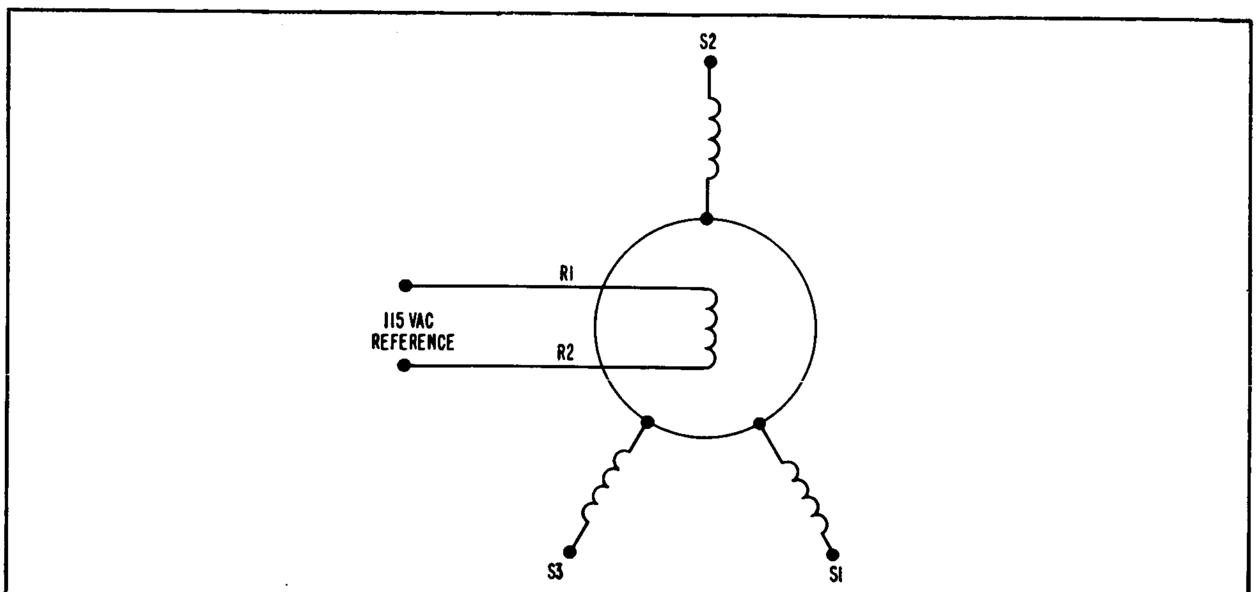



Figure 4-12. Synchro Transmitter or Receiver, Schematic Diagram

of the synchro induces voltages in the stator windings. The magnitude of the voltage induced in a given stator winding depends on the angle which the rotor makes with that stator winding, and the phase angle of the voltage in a stator winding with respect to the rotor voltage in a stator winding with respect to the rotor voltage is always zero or 180 degrees. The voltages in the windings of a synchro stator are shown in figure 4-13. The curves in the illustration are plots of the voltage magnitudes and phase against the angle of the rotor. The voltage across each stator winding (i. e., from the winding terminal to the common connection of the three windings) varies from 52 VAC (rms) of one phase polarity through zero to 52 VAC of the opposite phase polarity as the rotor is turned. Due to the way the rotor and stator windings are arranged on a synchro, these curves are sinusoidal. However, they should not be confused with timegraphs of sinusoidal voltages. All of the voltages in a synchro system are a-c, they are either in phase or 180 degrees out of phase with each other, and their effective (rms) values vary with the angle of the rotor as shown on the illustration.

(c). In practice no external connection is made to the common connection of the three stator windings, and the synchro system stator voltages are taken between the three pairs of windings: S2 and S1, S2 and S3, and S1 and S3. The voltage magnitude and phase between these pairs of windings is shown in figure 4-14 for varying rotor angles.

(d). The simplest form of synchro system consists of a transmitter and a receiver. A transmitter and a receiver which are suitable for use in the same system generally are electrically identical, but differ somewhat mechanically. The most notable mechanical difference is the use of a damper on the receiver in order to prevent it from oscillating. The transmitter, being mechanically coupled to an antenna or handwheel through a gear train, requires no damper. Hence, if mechanical coupling can be arranged, a receiver can be used as a transmitter, but a transmitter generally cannot be used as a receiver.

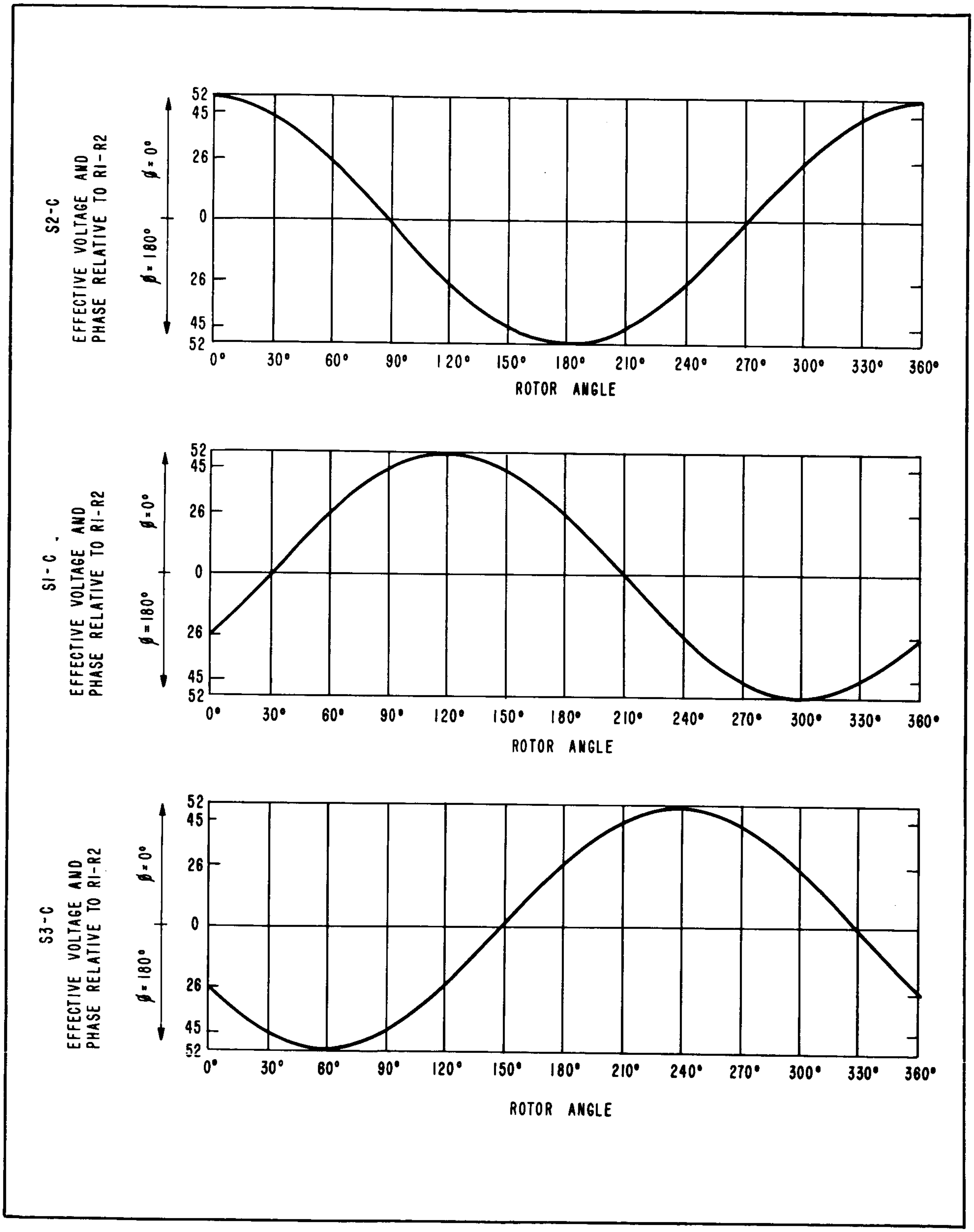



Figure 4-13. Voltages in Synchro Stator Windings

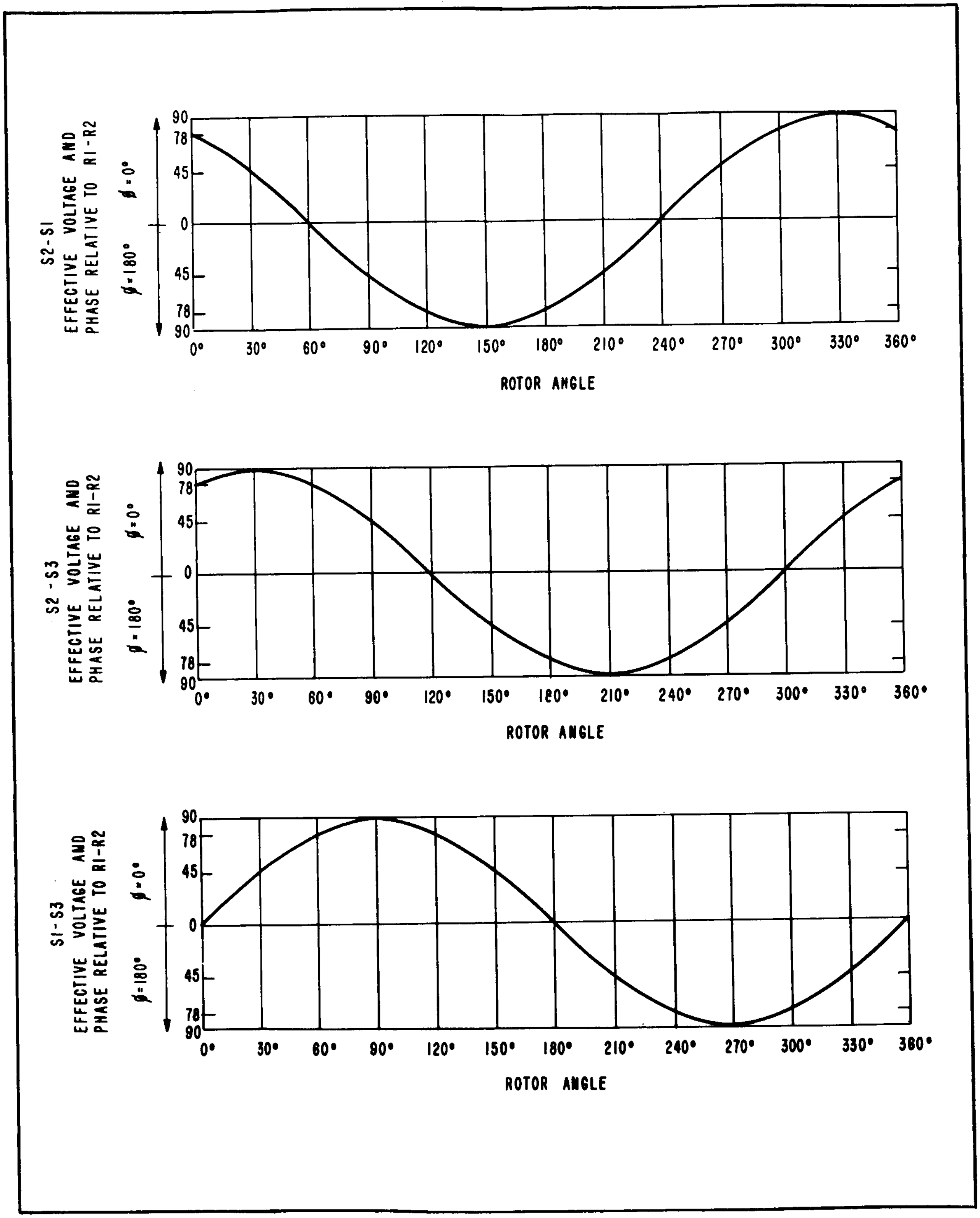



Figure 4-14. Voltages between Synchro Stator Windings

(e). The manner in which a synchro system works is illustrated in figures 4-15 and 4-16. The stator windings of the transmitter are connected to the corresponding windings on the receiver; S1 to S1, S2 to S2, and S3 to S3. The rotor windings of the transmitter and receiver are connected in parallel and are supplied by 115 VAC reference.

**Note**

> All of the rotor windings in a synchro system must be connected to a common reference voltage source. Otherwise, phase differences between voltage sources will cause inaccuracies in the system.

With the reference voltage applied and both of the rotors at zero degrees, as shown in figure 4-15, voltages in the stator windings are 52 VAC for the S2 windings and 26 VAC each for the S1 and S3 windings. The arrows on the illustration adjacent to the windings indicate relative instantaneous current direction (relative phase). As can be seen from figure 4-15, with both the transmitter and receiver rotors at the zero position, the magnitudes of the voltages induced in the stator windings of the transmitter and receiver are the same, and the phases are such that no current flows through the windings. With no current in the windings, no torque is developed and both synchros remain at rest. This condition of dynamic balance (voltages and phases such that no current flows in the stator windings) exists whenever, but only so long as, the rotors of the transmitter and receiver are at the same angular position.

(f). If the synchro receiver is held at one position and the transmitter turned to another position, unbalanced stator voltages are developed and current flows in the windings. An example of this condition is shown in figure 4-16. The rotor of the transmitter is turned to 30 degrees, inducing stator voltages of the magnitudes and relative phases shown on the illustration. (For the magnitude and relative phase of the induced stator voltages at any position of the rotor, see figure 4-13.) The rotor of the receiver, however, is at a different position, zero degrees, and the voltages induced in its stator windings are different from those in the stator of the transmitter. Currents with the relative phases shown flow in the stator windings. The magnitudes indicated for the currents are typical values. These currents cause torque to be applied to the rotors of the synchros and both of the rotors try to turn. Under the conditions shown on figure 4-16, the transmitter rotor will try to turn in a counterclockwise direction and the receiver rotor in a clockwise direction. The transmitter rotor, when it is mechanically coupled to an antenna or a handwheel, is not free to turn, but the receiver rotor is free to turn. Thus, the receiver rotor turns to the same position as the transmitter rotor and the system comes to dynamic rest. In the same manner, if the transmitter rotor is turned to some new position, the receiver rotor follows. The synchros used in the acquisition system have sufficient sensitivity that as long as reference voltage is applied and the units are operating normally, a receiver will always follow the transmitter to which it is connected within a small fraction of a degree; the receiver is always at virtually the same position as the transmitter, regardless of whether the transmitter is stationary or is being turned. Hence, a pointer or dial attached to the receiver rotor provides an indication of the angular position of the device — in most cases an antenna — to which the transmitter rotor is coupled.

(g). Either a single receiver or several receivers in parallel may be driven by a single transmitter. The acquisition system employs both of these arrangements.

(h). A variety of nomenclature is applied to synchros. The most common of these are listed and explained below:

1. Torque receiver (TR): a synchro receiver.
2. Torque transmitter (TX): a synchro transmitter which can drive a relatively large mechanical load (on the receiver or receivers connected to the transmitter).
3. Control transmitter (CX): a synchro transmitter which can drive only a relatively small mechanical load (on the receiver or

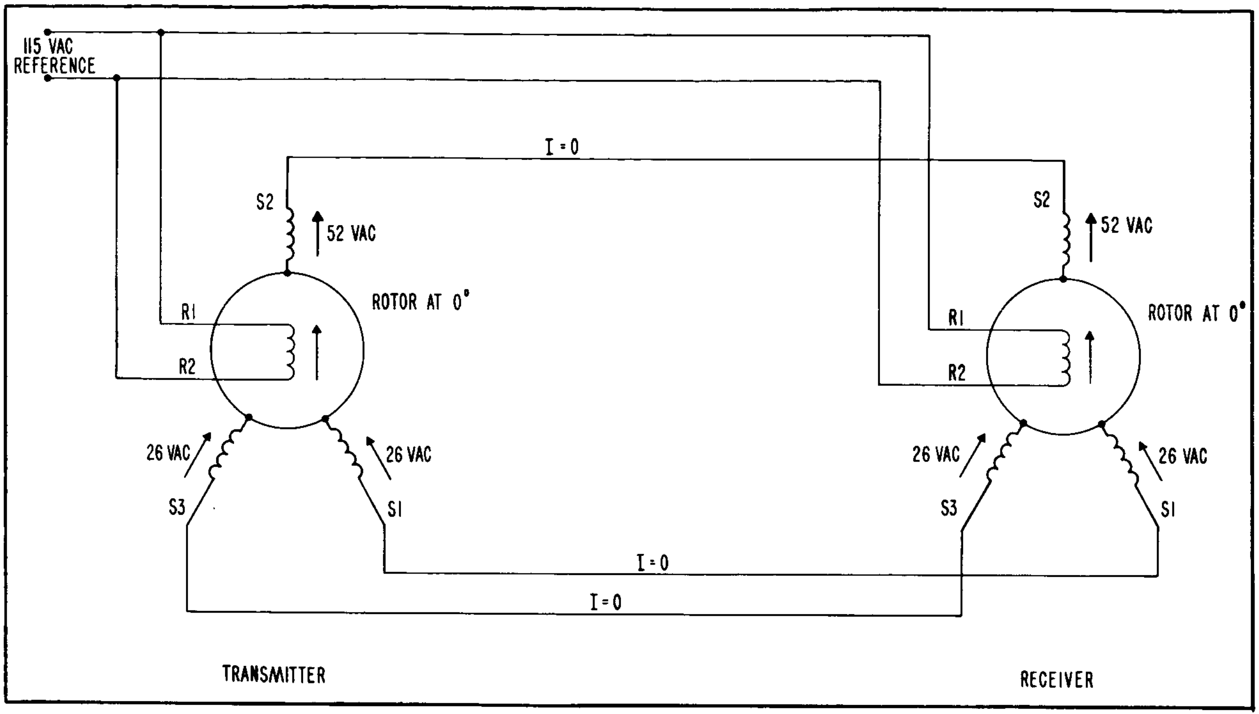



Figure 4-15. Simple Synchro System with Transmitter and Receiver Rotors at the Same Position, Schematic Diagram

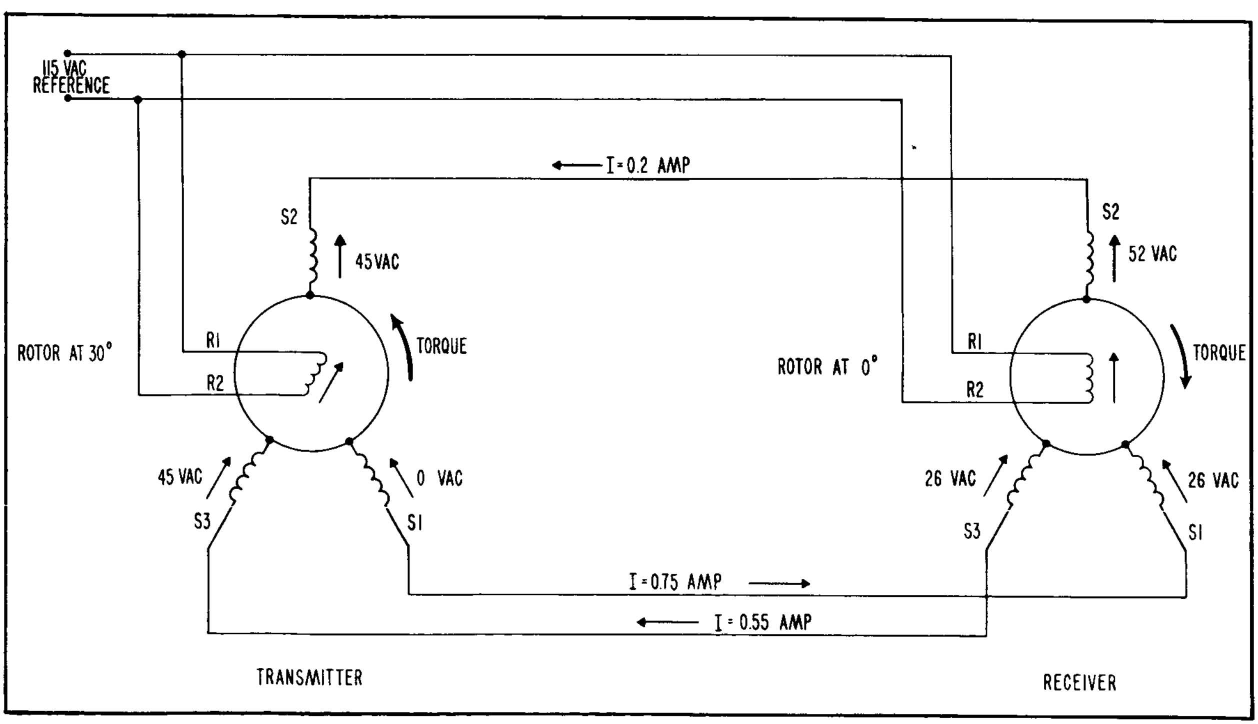



Figure 4-16. Simple Synchro System with Transmitter and Receiver Rotors at Different Positions, Schematic Diagram

receivers connected to the transmitter).

**Note**

Both torque transmitters and control transmitters are synchro transmitters as described in the previous paragraphs, and except for the amount of load they can drive, they are the same.

4. Synchro generator: a synchro transmitter.

5. Synchro motor: a synchro receiver.

6. Control transformer (CT): this device is described in the following paragraph.

7. Selsyn, autosyn: trade names for synchros.

(2). CONTROL TRANSFORMERS

(a). The control transformer is a type of synchro unit widely used in automatic control systems. Its function is to supply an a-c voltage whose magnitude and phase polarity depend on the difference between the angular position of its rotor and the rotor of the synchro transmitter which is connected to it. Control transformers are used in various places in the antenna positioning systems which are part of or are connected to the acquisition system.

(b). Control transformers are similar to synchro transmitters and receivers, but differ from them in several important respects:

1. The rotor winding of a control transformer is never connected to an a-c supply and therefore induces no voltage in the stator windings. As a result, the stator current is determined only by the impedance of the windings, which is high, and is not appreciably affected by the rotor's position. (A matched set of delta-connected capacitors is connected across the stator leads near the control transformer. These capacitors correct the lagging power factor of control transformer coils and reduce the current drawn from the synchro transmitter.) Also, there is no appreciable current in the rotor, and the rotor does not tend to

turn to any particular position when voltages are applied to the stator. The rotor of a control transformer is always turned by some mechanical device, such as an antenna. (Or more specifically, by gearing between an antenna and the control transformer.)

2. The zero position of a control transformer is that at which the rotor is at right angles to the S2 stator winding. (See figure 4-17.) Note that this zero position differs by 90 degrees from that of a transmitter or receiver (figure 4-15).

(c). The manner in which a control transformer is connected in a system is shown in figure 4-18. The stator windings of the control transformer are connected to the corresponding stator windings of a synchro transmitter. The rotor of the control transformer is usually connected to a servo amplifier. With a reference voltage (115 VAC) applied to the rotor of the transmitter, voltages are induced in the stator windings of the transmitter. These voltages are representative, by magnitude and phase polarity, of the angular position of the rotor. Since the stators of the control transformer and transmitter are connected, currents flow in the windings, and if the control transformer

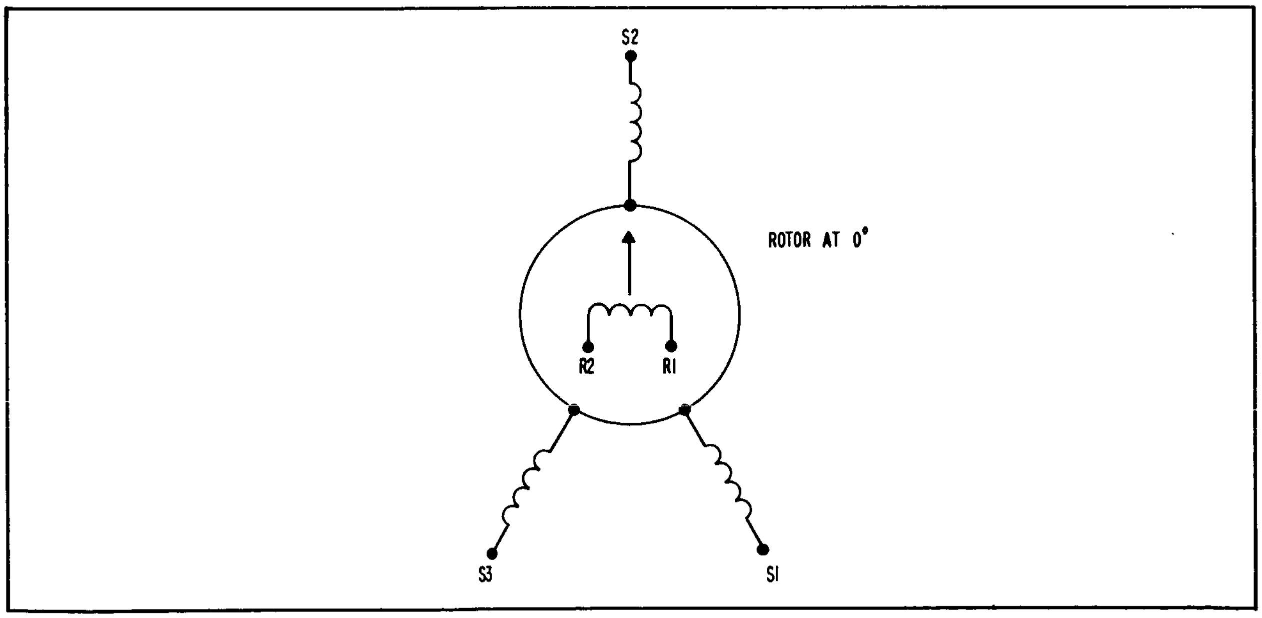



Figure 4-17. Control Transformer, Schematic Diagram

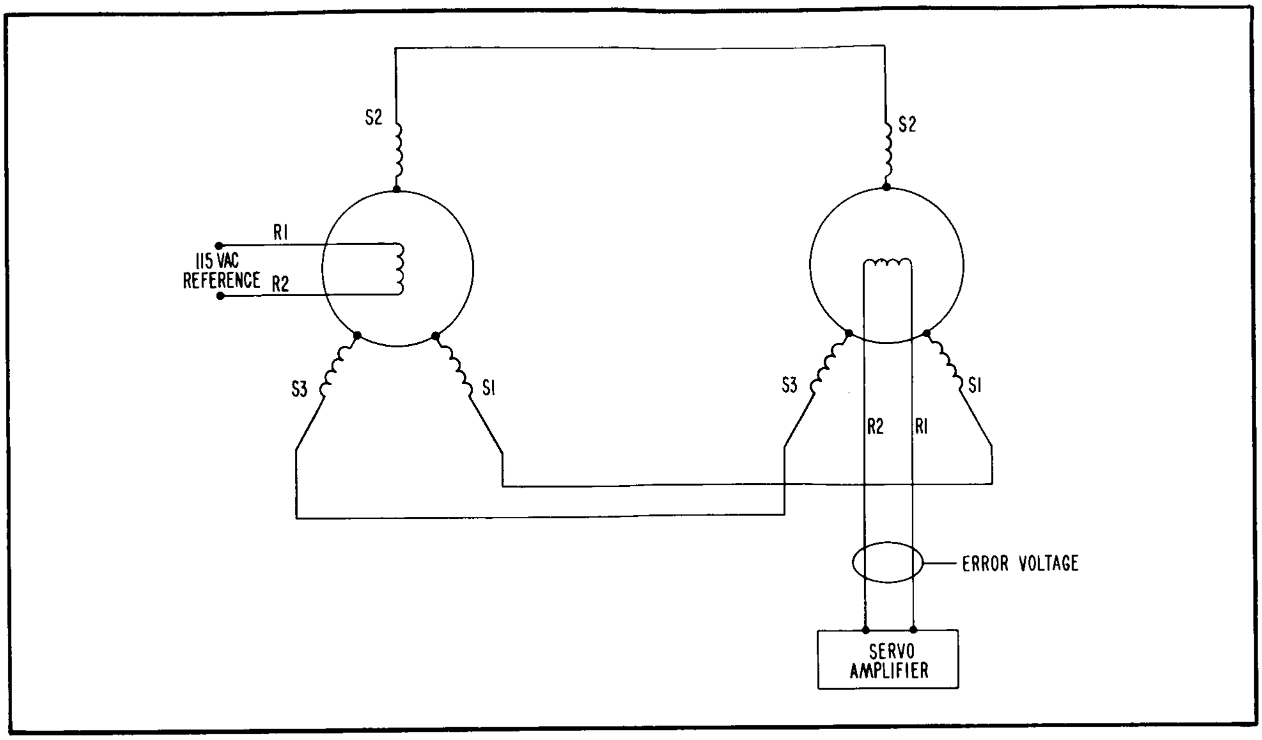



Figure 4-18. Control Transformer and Synchro Transmitter Connections, Schematic Diagram

rotor is at any position except the same as or 180 degrees different from that of the transmitter rotor, voltage is induced in the control transformer rotor.

(d). The voltage induced in the control transformer rotor when it is at a position different from the transmitter rotor depends in magnitude and phase polarity on the angular difference between the two rotors. The voltage variation for 360 degrees of angular difference between the positions of the two rotors is shown on figure 4-19. Note that the rotor voltage has two null points: at positions which are zero and 180 degrees different from the position of the transmitter rotor. When the control transformer rotor is between zero and 180 degrees relative to the transmitter rotor (voltage curve above zero line on figure 4-19), the control transformer rotor voltage is of one phase; between 180 and 360 degrees (voltage curve below the line on figure 4-19), it is of the opposite phase.

(e). For a description of how control transformers are used, refer to paragraph 4-2. F.

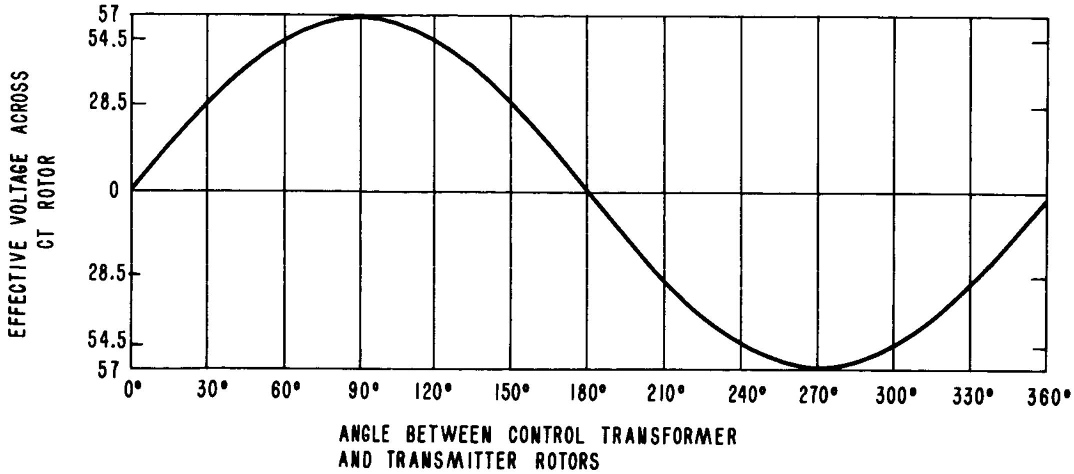



**Figure 4-19. Voltages in Rotor Winding of Control Transformer**

F. TYPICAL SERVO SYSTEMS UTILIZING SYNCHROS

In the acquisition system and the equipment associated with it there are a number of servo systems which utilize synchros. A simplified version of a servo system of this type is described in this paragraph in order to provide a basic understanding of how mechanical position data is converted to electrical form, transmitted over a distance, and converted back to mechanical form. Figure 4-20 illustrates such a system.

(1). The principal elements of the system are a mechanical input (the handwheel on figure 4-20), a mechanical/electrical converter (the synchro transmitter), an electrical/mechanical converter (the servo loop consisting of the control transformer, the servo amplifier, and the servo motor), and a mechanical output, or load (the antenna).

(2). The output of the synchro transmitter is a function of the position of its rotor, which is mechanically coupled to the handwheel. The output of the synchro transmitter is connected to the control transformer, whose rotor may or may not be at the same angular position as that of the transmitter. (Refer to paragraph 4-2. E. for a description of the operation of synchro transmitters and control transformers.) When the control transformer rotor is not at the same position as the rotor of the transmitter, a voltage is developed in the control transformer rotor winding. The magnitude and phase polarity of this voltage depend on the angular difference between

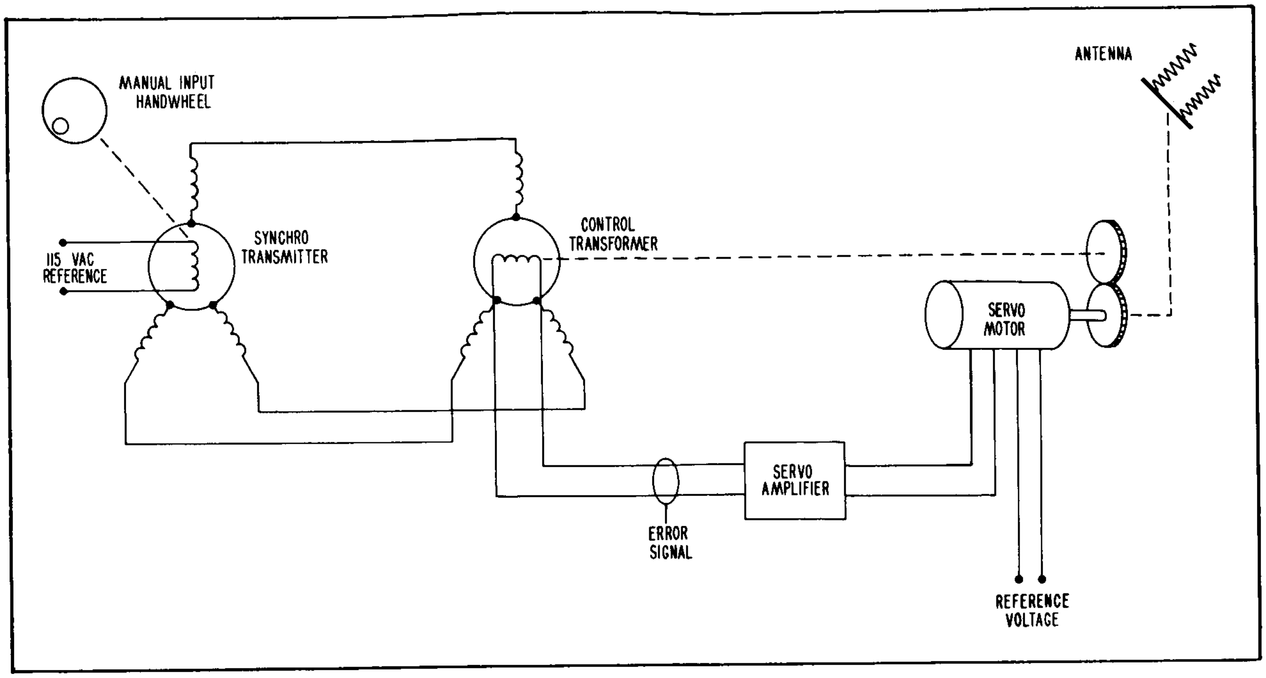



**Figure 4-20. Typical Servo System Utilizing Synchros, Simplified Schematic Diagram**

the positions of the two rotors. This voltage, the error signal of the servo loop, is applied to the servo amplifier, where it is amplified and applied to the variable-phase field winding of a two-phase motor. A reference voltage is applied to the fixed-phase field of the motor. The direction of rotation of the motor depends on the phase of the error signal (relative to the reference voltage), and the speed of rotation of the motor depends on the magnitude of the error signal. When no error signal is applied, the motor does not rotate. The motor armature is coupled through gearing to the rotor of the control transformer and to the mechanical load, in this case an antenna. The gearing and phase of signals in the servo loop are so arranged that whenever there is an error signal developed across the rotor of the control transformer, the motor turns in the direction which results in a reduction of the magnitude of the error. Stated another way, the motor drives the rotor of the control transformer so that it is always at very nearly the same position as the rotor of the synchro transmitter. Since the antenna is also driven by the motor, it too is kept at virtually the same position as the transmitter rotor. Thus, the antenna follows the handwheel which turns the synchro transmitter rotor.

(3). The servo systems actually used in the acquisition system and associated equipment are generally more elaborate than that just described, but the principal elements of the system are the same. For instance, the active acquisition aid uses an amplidyne and a d-c servo motor in each channel of its antenna positioning system. The d-c servo motor, however, has exactly the same basic function as the two-phase, a-c motor on figure 4-20, and the amplidyne is in its function simply an additional two-stage servo amplifier.

# SECTION V
# SYSTEM MAINTENANCE

## 5-1. GENERAL

This section includes information, instructions, and procedures for preventive maintenance, trouble shooting, adjustments and repair, lubrication, special tools, and test equipment. Detailed information is given for the acquisition data console and its components; for other equipment in the system, system-level and general information is given. For detailed information on the other equipment, refer to the applicable equipment manuals listed in table 1-II.

**WARNING**

Antenna drive power cutoff switches and warning lights are mounted below the platforms of the active acquisition aid, the receiving antenna, and the transmitting antennas. (Refer to Section II for the location of the switches.) When drive power is applied to the pedestal, the warning light is lit. The switch should be turned off (thus removing drive power from the pedestal) before going onto the antenna platform for maintenance or repair. For a schematic diagram of the active acquisition aid safety circuit, which includes a cutoff switch and warning light, see figure 7-13.

## 5-2. PREVENTIVE MAINTENANCE

### A. PREVENTIVE MAINTENANCE SCHEDULE

Table 5-I outlines the preventive maintenance procedures which are to be performed on all of the equipment in the acquisition system. Detailed procedures are discussed in paragraph 5-2. B. and the equipment manuals. For a list of equipment manuals and the equipment to which they apply, refer to table 1-II.

### B. PREVENTIVE MAINTENANCE PROCEDURES

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE

| Equipment | Maintenance To Be Performed | Refer To |
|---|---|---|
| | DAILY | |
| Active Acquisition Aid | Check cover plates on pedestal for watertightness. | Equipment manual |
| | Check all strip heaters for proper operation. | Equipment manual |
| | Check azimuth and elevation limit switches for proper operation. | Equipment manual |
| | Operate the pedestal both in azimuth and elevation for several minutes in order to keep the gearing well lubricated. | — |
| | WEEKLY | |
| All | Check for corrosion of painted and plated surfaces. Clean and resurface all corroded areas. | Paragraphs 5-2. B. (1). and (2). |
| | Check mechanical condition of switches to see that they are not loose or sluggish in their action. Replace any that appear likely to become defective. | — |
| All except Acquisition Data Console | Check the lamps or bulbs in all indicators. Replace any that are burned out. | Equipment manuals |
| Acquisition Data Console | Check and replace any burned out lamps in the 28 VDC power supply indicators. | Paragraph 3-2. B. |
| | Check and replace any burned out lamps in the source switch indicators. | Paragraph 3-2. C and D. |
| | Check and replace any burned out lamps in all of the indicators not covered by the previous two steps. | Paragraph 3-5. A. |

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

| Equipment | Maintenance To Be Performed | Refer To |
|---|---|---|
| | MONTHLY | |
| All | Perform general cleaning as necessary. Wipe off, vacuum off, or blow out dust, dirt, and sand. Clean dial plates (glass) on synchro displays. | — |
| | Check and correct as necessary the general condition of equipment. Check cables and wiring for worn or frayed insulation, check connectors to see that they are free from corrosion and are tight, and check terminal board connections for tightness. | — |
| Active Acquisition Aid | Check the conditions, placement, and dress of cables which wrap as the pedestal turns. | Equipment manual |
| | BIMONTHLY | |
| Active Acquisition Aid | Check the azimuth and elevation amplidyne and drive motor brushes and commutators. | Equipment manual |
| | Check the amount of backlash in the pedestal drive gearing. | Equipment manual |
| | SEMI-ANNUALLY | |
| Active Acquisition Aid | Check the mechanical friction of the pedestal (torque required for pedestal azimuth and elevation movement). | Equipment manual |
| | YEARLY | |
| Active Acquisition Aid | Disassemble azimuth and elevation amplidynes and clean and lubricate bearings and air circulating system. | Equipment manual |
| | Disassemble azimuth and elevation drive motors and check the condition of the bearings. | Equipment manual |

(1). PAINTED SURFACES

Painted surfaces which have corroded should be sanded to remove all of the corroded material and then painted with a color which matches the original. If matching paint is not available, it is preferred that the corroded surface be cleaned and painted with any available paint. When matching paint is obtained, areas with non-matching paint should be retouched for the sake of appearance.

(2). PLATED SURFACES

Corrosion of plated surfaces (cadmium, nickel or other) should be removed with sandpaper or emory cloth and sprayed or brushed with a clear lacquer. If a clear lacquer is not available, the corroded areas should be painted to prevent further corrosion until lacquer can be obtained.

5-3. TROUBLE SHOOTING

This paragraph provides information to aid in the isolation and correction of troubles in the acquisition system. It is concerned primarily with those malfunctions which affect the transmission of acquisition information; for information on a malfunction which affects only an individual piece of data source or data-using equipment, refer to the applicable equipment manual. Since the d-c indication and synchro portions of the acquisition system are essentially independent of one another, they are treated separately in the following discussions.

A. D-C INDICATIONS

The d-c indication circuits in the acquisition system are simple and straightforward and thus should pose little difficulty in trouble shooting. When a d-c indicator fails to operate normally, refer to the diagrams in Section VII (both the individual equipment schematics and the interconnecting circuit schematics) and to the applicable portions of paragraph 5-4 for information on isolating and ascertaining the source of trouble. The source of the trouble will, in most instances, be obvious on examination of the circuits involved. For information on inter-equipment wiring, refer to Section II, and for information on the internal wiring of equipment other than the acquisition data console, refer to the applicable equipment manual.

B. SYNCHROS

This paragraph comprises three sections: criteria for distinguishing actual troubles(requiring repair or replacement to correct them) from those malfunctions which can be corrected by adjustment; system trouble analysis; and circuit trouble analysis. The material on system trouble analysis provides information to aid in isolating the trouble to a particular circuit, or portion of the system. The material on circuit trouble analysis will aid in further isolating and determining the exact nature of the trouble. Both the system and circuit trouble analyses are concerned with actual troubles, not misadjustments. For synchro adjustment procedures, refer to paragraph 5-4. B.

(1). CRITERIA FOR DISTINGUISHING TROUBLE FROM MISADJUSTMENT

A synchro device is not operating properly when it does not accurately, rapidly, and smoothly transmit or follow the angular information which is fed into it. If a synchro has an error in the information it puts out, but the error is small and constant and the output of the synchro follows the input smoothly and rapidly, the cause of the improper operation is most likely misadjustment. (For a transmitter the input is mechanical and the output is electrical. For a receiver the input is electrical and the output mechanical. For a control transformer there are two inputs, one electrical and one mechanical, and one output, electrical.) If the synchro follows the input but with changing error, does not follow the input, spins, oscillates, hunts, follows erratically, has a large error (about 60 degrees or more), hums, overheats, or exhibits a combination of these or similar symptoms, the cause is most likely an actual trouble, either in the synchro being observed, another synchro connected to it, or the circuits between the two.

(2). SYSTEM TROUBLE ANALYSIS

Trouble shooting of the synchros in the acquisition system requires a thorough knowledge of the basic principles of synchro and the particular way in which they are used in the system. (Refer to Section IV.) With this knowledge it should be evident from the pertinent schematics, especially figure 5-8 and the interconnecting circuit schematics in Section VII, what the possible causes are for any given trouble. However, keep the following points in mind.

(a). A defective synchro can degrade the performance or cause abnormal operation of any or all synchros which are connected directly to it; for instance, where two receivers (or a receiver and a control transformer) are wired in parallel, a defect in one of them may cause abnormal operation of both. In cases where several synchros have abnormal operation, it will help in isolating the trouble to disconnect, one at a time, each of those involved to see which is affecting the operation of the others.

(b). The reference voltage (rotor) circuits are virtually the only circuits the azimuth and elevation channels have in common. If abnormal operation shows up in both azimuth and elevation channels in a portion of the acquisition system, look for trouble in the reference voltage circuits.

(c). Troubles that show up just after installation or replacement of synchro units are most likely due to incorrect wiring connections, not to defective units.

(d). When a trouble occurs, be sure to check all connecting circuits very thoroughly. Synchros themselves, although delicate instruments, are generally very reliable and trouble-free devices.

(3). CIRCUIT TROUBLE ANALYSIS

Once it has been determined that the source of trouble is in a particular circuit or portion of the system, circuit trouble analysis may be performed by one or a combination of the following means:

(a). Use of the synchro trouble shooting chart, figure 5-1: This chart graphically shows the symptoms and causes of most of the common synchro troubles, including incorrect wiring connections.

(b). Checks of connecting circuits: All of the circuits between synchros in a malfunctioning portion of the system should be checked in accordance with the applicable portions of paragraph 5-4 and the applicable equipment manuals. Also see the interconnecting circuit schematic diagrams in Section VII.

(c). Synchro voltage checks: In some instances it may not be possible to turn the suspected synchros as is necessary when using figure 5-1. In such instances the synchro voltages can be checked. Transmitter and receiver rotor voltage should always be 115 VAC. Transmitter, receiver, and control transformer stator voltages should be as shown by the curves of figure 4-14. Control transformer rotor voltage should be as shown in figure 4-19.

## 5-4. ADJUSTMENTS AND REPAIR

### A. GENERAL

This paragraph describes, on an individual basis, adjustment and repair procedures for synchros, the 28 VDC power supply, relays, and switch and indicator assemblies. For detailed information on other components of the acquisition system, see the applicable equipment manuals. The repair procedures given here are based on the assumption that a particular component, such as a relay, switch, or synchro, is known or suspected to be malfunctioning. The procedures are for the isolation and correction of the specific cause of trouble. For general, or system, trouble shooting procedures, see paragraph 5-3.

### B. SYNCHRO ALIGNMENT

#### (1). GENERAL

(a). This paragraph describes procedures for alignment and zeroing of synchro transmitters, receivers, and control transformers individually and while operating in a system.

(b). In a general sense, "zeroing" a synchro means adjusting it mechanically so that it will work properly in a system with one or more other synchros. Specifically, "zeroing" means aligning the mechanical and electrical zero positions of a synchro. Mechanical zero of a synchro is defined as the rotor position at which the mechanical device coupled to the synchro is at its zero position. For instance, a synchro transmitter coupled to the elevation drive of an antenna is at mechanical zero when the antenna is at zero degrees elevation; and a synchro receiver driving an azimuth indicator is at mechanical zero when the indicator pointer or dial reading is zero degrees azimuth. Electrical zero of a synchro is defined as the position of the rotor when rated voltage is applied to the rotor, when there is no voltage difference between S1 and S3, and when rated voltage is applied between S2 and S1-S3 in such a way that the voltage at S2 (measured with respect to S1-S3) is in phase with the voltage at R1 (measured with respect to R2). The applied voltages and the rotor position at electrical zero are shown in figure 5-2. The voltages shown are the rated values for the synchros used in the acquisition system. For purposes of definition, the arrangement shown in figure 5-2 applies both to synchro transmitters and receivers, and it is actually used for zeroing receivers; however, since when in operating position they are not free to turn, synchro transmitters are more conveniently zeroed by a different procedure, which is described below. The electrical zero position of a control transformer is as described in paragraph 4-2.E.(2). and shown in figure 4-17.

(c). Certain of the synchro receivers used in the acquisition system require special procedures for zeroing. The requirement for special procedures derives from the fact that the R2 and S2 windings are internally connected in all synchros on the acquisition data console. The procedures given below of course take this condition into account and except where noted are applicable to all synchros connected to the acquisition system.

(d). The procedures that follow comprise four sections: one for individual zeroing of transmitters, one for individual zeroing of receivers, one for individual zeroing of control transformers, and one for in-system alignment of transmitters and receivers. The first three

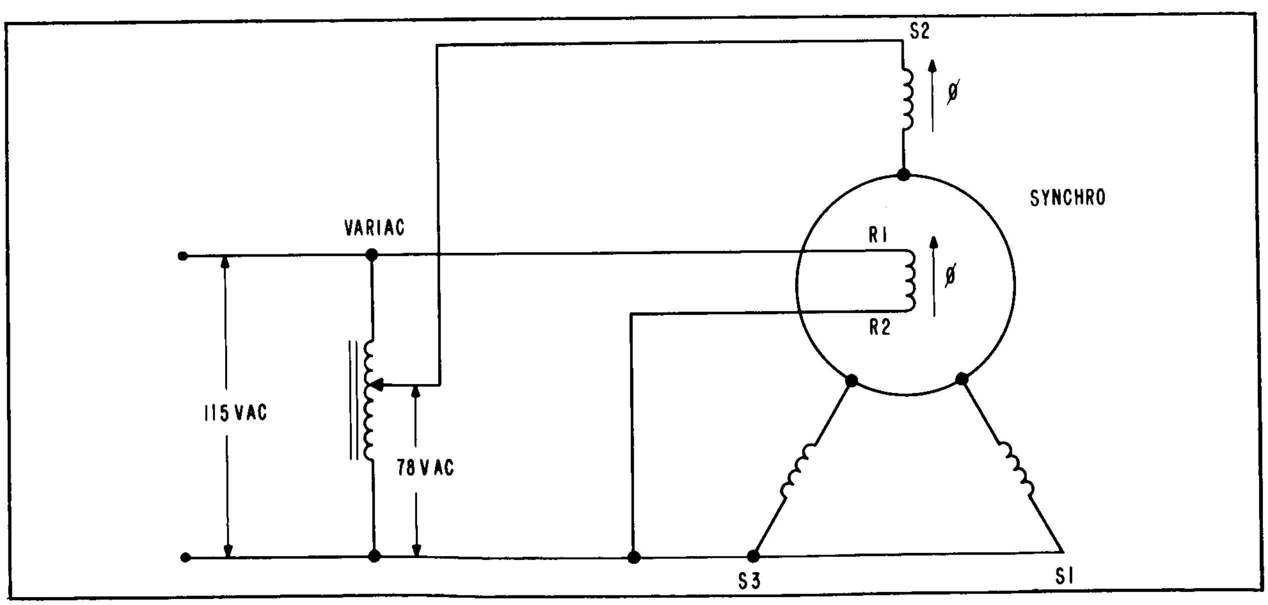



Figure 5-2. Conditions at Electrical Zero of a Synchro

apply, with exceptions as noted, to any individual synchro transmitter, receiver or control transformer, in the acquisition system.

(2). SYNCHRO TRANSMITTERS

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous; i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. In practice, however, it is usually not necessary to follow the complete procedure, once the transmitter has been installed and operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). TRANSMITTER ZEROING PROCEDURE— COMPLETE

1. Set the device to which the synchro is mechanically coupled to its zero degree position (azimuth or elevation).
2. Turn off reference voltage to the synchro (115 VAC).
3. Disconnect the stator leads (S1, S2, S3) from the synchro.

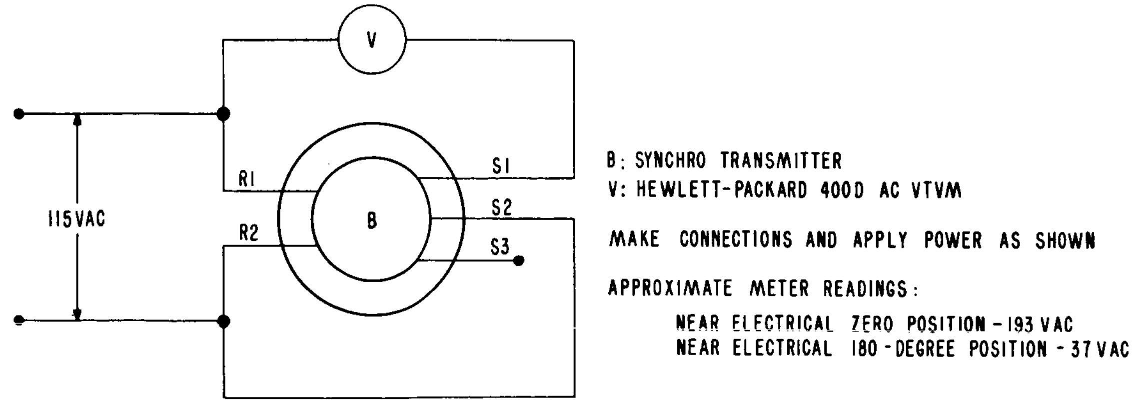



Figure 5-3. Method of Locating Approximate Position of Synchro Transmitter Electrical Zero

4. Connect a jumper between synchro terminals R2 and S2 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-3.)

**CAUTION**

Before connecting the jumper between R2 and S2, make sure that the synchro has no internal jumpers which, when the external jumper is connected, would result in a short circuit of the 115 VAC power.

5. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro:

a. If the meter reading is approximately 193 volts, the synchro is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 37 volts, the synchro is near electrical 180 degrees. Turn off the 115 VAC reference, loosen the screws which hold the case, and turn the case of the synchro halfway around, so that the meter reading is approximately 193 volts. Then proceed with the simplified zeroing procedure below.

c. If the meter reading is something roughly midway between 37 and 193 volts, the synchro is not near either zero or 180 degrees. Proceed with the simplified zeroing procedure to set the synchro near zero or 180 degrees. Then repeat the complete zeroing procedure.

(b). TRANSMITTER ZEROING PROCEDURE— SIMPLIFIED

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

**Note**

See paragraph 5-4.B.(2). for restrictions on the use of this procedure.

2. Turn off reference voltage (115 VAC) to the synchro.
3. Disconnect stator leads (S1, S2, S3) from the synchro.

4. Connect a voltmeter (Hewlett-Packard 400D) between synchro terminals S1 and S3. (See figure 5-4.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the zeroing procedures, set the meter to successively lower scales.

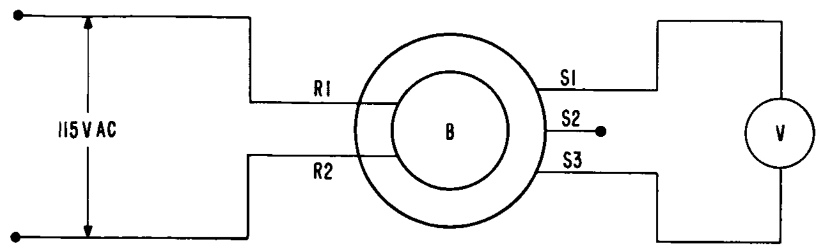



Figure 5-4. Method of Zeroing Synchro Transmitter

5. Loosen the screws which hold the case of the synchro so that the case is free to turn.
6. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.
7. Turn the case of the synchro in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the synchro back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the synchro.
8. With the synchro set at electrical zero, tighten the screws which hold the case in place.
9. Turn off the reference voltage (115 VAC) and reconnect stator leads (S1, S2, S3).

(3). SYNCHRO RECEIVER ZEROING PROCEDURE

(a). Turn off reference voltage (115 VAC) to the synchro.

(b). Disconnect stator leads (S1, S2, S3) from the synchro.

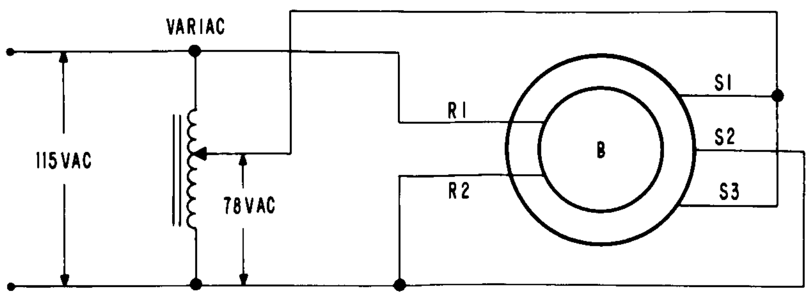



Figure 5-5. Method of Zeroing Synchro Receiver

(c). Connect a variac (General Radio Type W10MT) as shown in figure 5-5.

(d). Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

(e). Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at 180 degrees.

(f). Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now zeroed.

**Note**

The synchro receivers on the acquisition data console are so constructed that they cannot be zeroed by turning the case; the pointer must be turned on the rotor shaft. Partially disassemble the synchro and remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4. C.

(4). CONTROL TRANSFORMERS

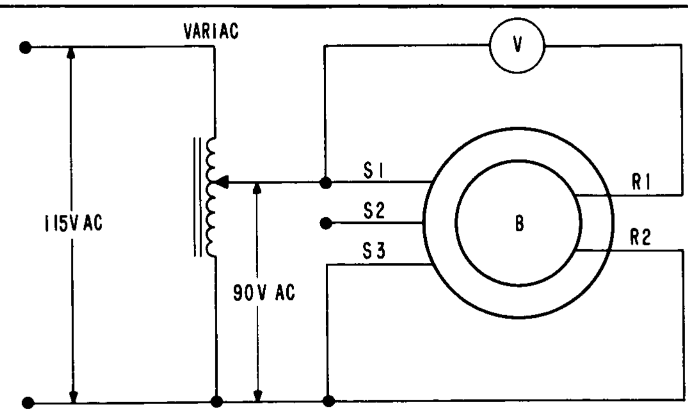
Two procedures, one complete and one simplified, for zeroing control transformers are given below. As was discussed for the case of synchro transmitters in paragraph 5-4. B. (2)., the simpler procedure should be used only when the approximate electrical zero position of the control transformer is known. However, in practice the approximate electrical zero position usually is known and the simplified procedure can, in most cases, be used.

(a). CONTROL TRANSFORMER ZEROING PROCEDURE — COMPLETE

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals R2 and S3 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-6.)




B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER.
(MINIMUM READING SHOULD BE ABOUT 30 VOLTS).

Figure 5-6. Method of Locating Approximate Position of Control Transformer Electrical Zero

4. Connect a variac (General Radio Type W10MT) between terminals S1 and S3 as shown on figure 5-6 and apply 90 VAC to these terminals.

a. If the meter reading is approximately 30 volts, the control transformer is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 120 volts, the control transformer is near electrical 180 degrees. Turn off the power, loosen the screws which hold the case, and turn the case of the control transformer halfway around. Turn the power back on; the meter reading now should be approximately 30 volts. Proceed with the simplified zeroing procedure.

(b). CONTROL TRANSFORMER ZEROING PROCEDURE — SIMPLIFIED

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

**Note**

See paragraph 5-4. B. (4). for restrictions on the use of this procedure.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals S1 and S3 and connect a voltmeter (Hewlett-Packard 400D) between terminals R1 and R2. (See figure 5-7). To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the procedure, set the meter to successively lower scales.

4. Loosen the screws which hold the case of the control transformer so that the case is free to turn.

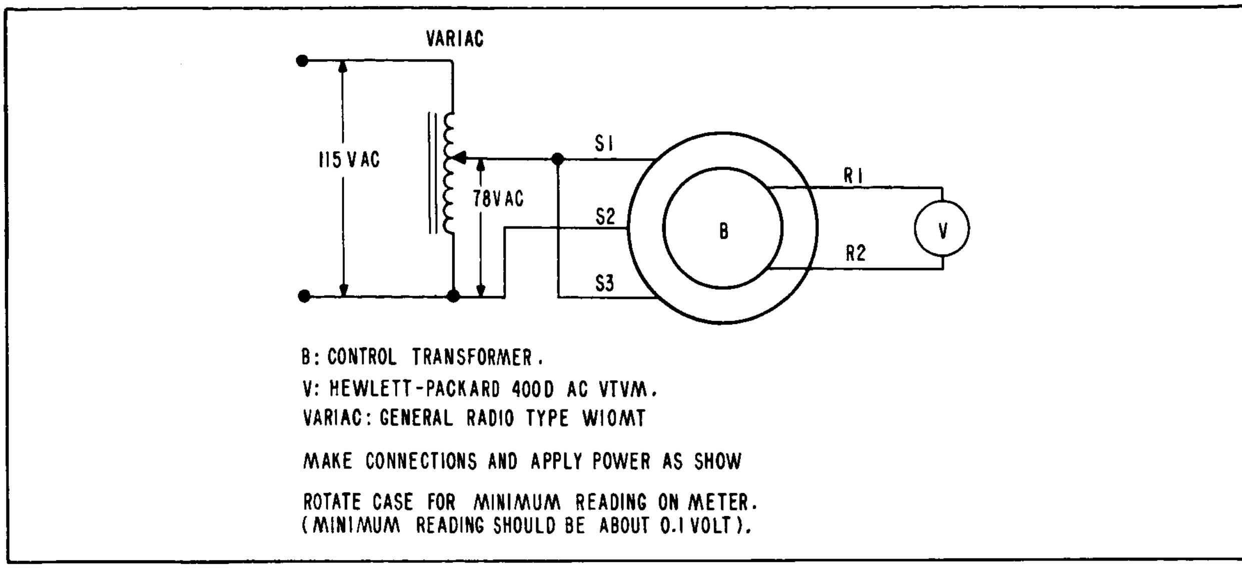



**Figure 5-7. Method of Zeroing Control Transformer**

5. Connect a variac between terminals S1 and S2 as shown on figure 5-7 and apply 78 VAC to these terminals.

6. Turn the case of the control transformer in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the control transformer back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the control transformer.

7. With the control transformer set at electrical zero, tighten the screws which hold the case in place.

8. Turn off power and reconnect the control transformer for normal operation in its circuit.

(5). SYSTEM ALIGNMENT

In a system consisting of a synchro transmitter and a synchro receiver or control transformer, there are three places where misalignment errors commonly arise. These three are the transmitter, the receiver, and the circuits which connect the transmitter to the receiver. When the connecting circuits consist simply of cabling and/or fixed transformers, no adjustments can be made to them; errors can be corrected only at the transmitter or receiver. In a simple system consisting of a single transmitter and receiver or control transformer (a control transformer for the purposes of this discussion being equivalent to a synchro receiver), a misalignment error can be corrected by adjusting either one of the two elements (transmitter or receiver). In such a simple system it is immaterial where the source of error actually is; a misadjustment of the transmitter can be compensated for by adjusting the receiver to introduce an equal and opposite error. The only criterion for proper operation is that when the device which drives the synchro transmitter is pointing at a given angle, the synchro receiver indicates that angle. However, the synchros in the acquisition system are not in a simple arrangement like that just described, and although shortcut methods can and should be used as the technician becomes familiar with the configuration and characteristics of the system, the general procedure given below should be followed in most cases:

(a). When an error is noted in the synchro system, determine if possible whether the error is due to a "trouble" or misadjustment. The criteria for making this determination are discussed in paragraph 5-3.

(b). Isolate the source of the error as much as possible. That is, where there is more than one receiver connected to a transmitter, check all of the receivers to see whether the error shows up on all or only one; switch between two transmitters which can be connected to a single receiver. (See figure 5-8. This illustration is a schematic of both the azimuth and elevation synchro systems, which are virtually identical.)

(c). Individually check the adjustment of each of the units (transmitter, receiver, or control transformer) for possible source of the particular error. Careful adjustment of the individual units should correct the majority of system errors. Individual check and adjustment procedures for synchro transmitters and receivers and control transformers are given in paragraphs 5-4. B. (2)., (3)., and (4).

(d). When all of the individual units involved have been properly adjusted and the error still persists, its source must be in the connecting cabling. An error arising in the cabling, so long as it is constant

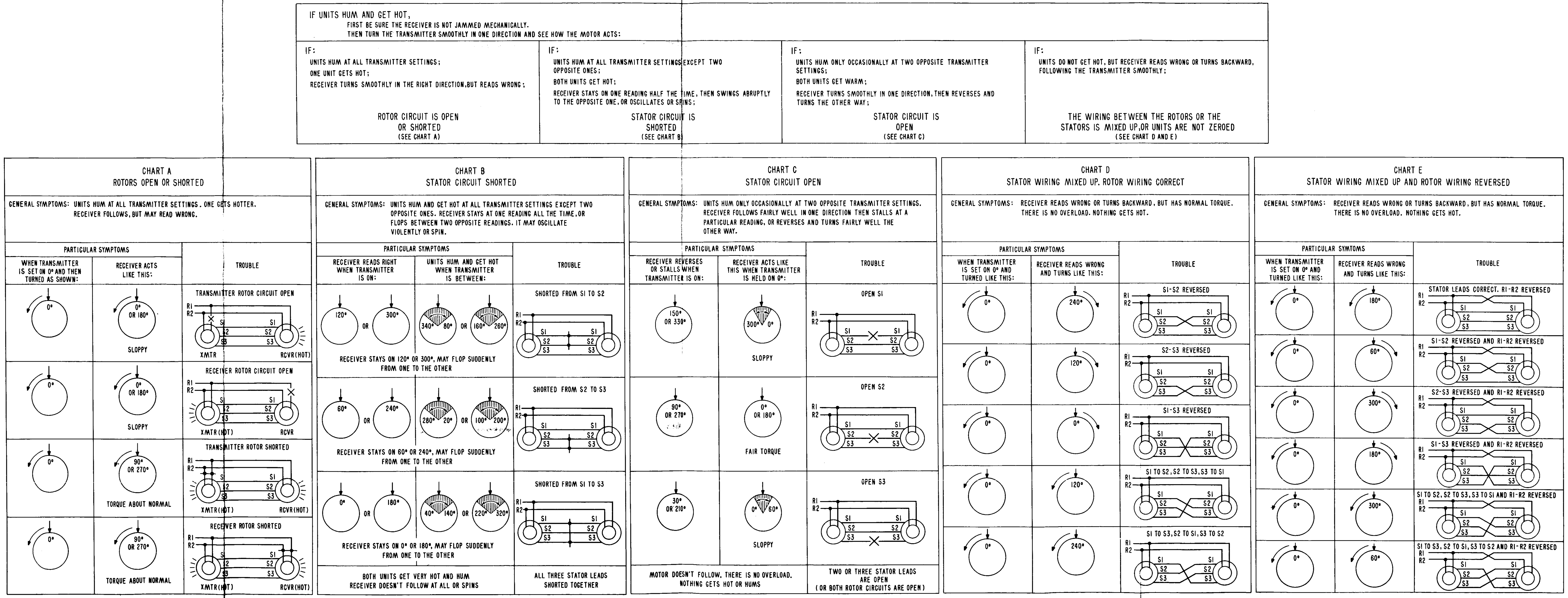



Figure 5-1. Synchro Troubles and Symptoms

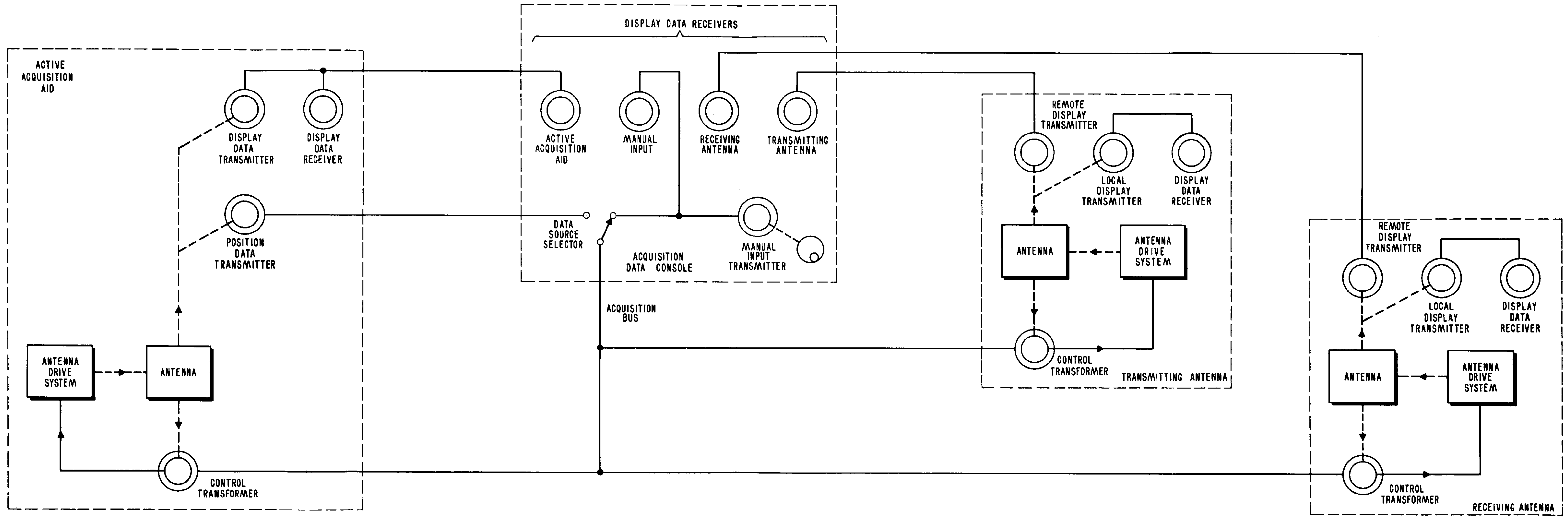



Figure 5-8. Azimuth and Elevation Synchro System, Schematic Diagram

at all angular positions of the synchros, can be compensated for by introducing equal and opposite errors into the synchro receivers. Thus, when individual adjustment of the units of the system does not correct the error, system alignment should be made as follows:

1. Do not change the synchro transmitters; i.e., leave these units as they were set in accordance with the individual adjustment procedure.

2. Set the device mechanically coupled to the transmitter to a known position (azimuth or elevation).

3. For synchro receivers, loosen the screws which hold the case and with the synchros energized (115 VAC applied) turn the case so that the receiver indication is the same as the position of the antenna.

**Note**

The case of the synchro receivers on the acquisition data consoles cannot be turned; the pointer must be turned on the rotor shaft. Refer to the note in paragraph 5-4. B. (3). (a).

4. Before adjusting a control transformer to compensate for errors introduced by interconnecting cabling, be sure that changing the setting of the control transformer will not introduce an error into the positioning system with which the control transformer is associated.

C. SYNCHRO REPAIR

(1). REPAIR PROCEDURES

(a). It is recommended that major repairs on synchro devices (transmitters, receivers, and control transformers) not be attempted in the field. However, minor repairs such as replacing broken pointers or dial plates and repairing broken connections (where wiring is accessible) can be made. For information on replacement of defective parts or gaining access to internal wiring of synchros on the acquisition data consoles, refer to the disassembly and assembly procedures below. For information on other synchros in the acquisition system, refer to the applicable equipment manuals.

(b). When there is a question as to whether a synchro is defective and requires replacement, the winding resistances should be checked. For the synchros on the acquisition data consoles the d-c resistance of the stator windings (S1-S2, S2-S3, and S1-S3) should be about 95 ohms at room temperature, and the d-c resistance of the rotor windings (R1-R2) should be about 85 ohms, also at room temperatures. For synchros in other equipment, comparable d-c resistance measurements should be obtained. (When a resistance measurement is doubtful, it is a good idea to compare the resistances of corresponding windings in two identical synchros, or two windings of the same synchro.)

(2). DISASSEMBLY

The disassembly procedure described in this paragraph applies to the synchro receivers on the acquisition data consoles. See figure 5-9.

(a). Dismount the synchro from the panel by removing the four mounting screws and nuts.

(b). Remove the eight screws which hold the bezel onto the front housing. Remove the bezel, dial plate, and gasket and set them aside.

(c). Pull or pry the pointer off the end of the rotor shaft. As shipped from the factory the pointer is secured to the shaft with a drop of glue, and considerable force may be necessary to break it loose. However, the pointer is fairly delicate, and care should be exercised not to damage it during removal.

(d). Pull out the retaining ring and remove the dial.

(e). Remove the four screws which hold the front and rear housings together. Remove the front housing and "0" ring. With the front housing removed, only the wires from the connector to the synchro itself hold the synchro in the rear housing. Do not hold the rear housing in such a position that the connecting wires support the weight

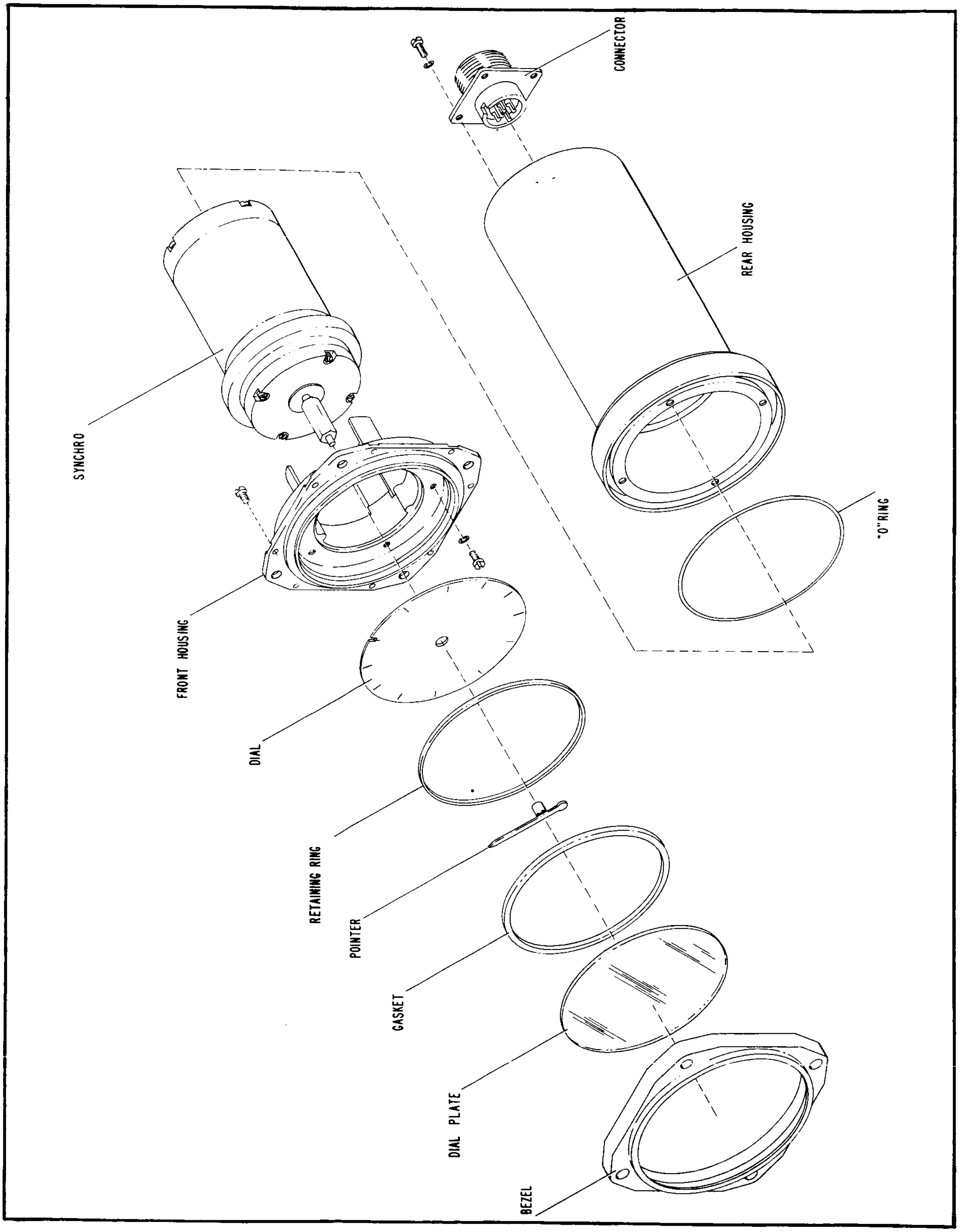



Figure 5-9. Acquisition Data Console Synchro Receiver, Exploded View

of the synchro.

(f). Remove the four screws which fasten the connector to the rear housing.

(g). Pull the connector as far away from the rear housing as the wiring permits and unsolder the wires from the connector pins. Drop the synchro itself out of the rear housing. This is as far as field disassembly should proceed.

(3). ASSEMBLY

Assembly of the synchro receivers on the acquisition data consoles is the reverse of the disassembly procedure, except that particular attention should be paid to the pointer. Be sure that the pointer is replaced at the proper angle on the rotor shaft (refer to paragraph 5-4. B. (3)., and if necessary crimp the pointer socket slightly to obtain a secure fit on the rotor shaft.

D. 28 VDC POWER SUPPLY

The acquisition data console 28 VDC power supply comprises two principal parts; one is the control circuits, and the other is the dual power supply. The control circuits consist of relays and diodes, on the relay chassis, and the switch assemblies (with indicators) on acquisition data panel number 2. The dual power supply consists of a front panel (with a switch, fuses, and a power-on indicating lamp) and power supplies number 1 and 2, each of which, in turn, consists of a power supply unit and a filter unit. This paragraph describes adjustment and repair procedures for the control circuits and for the dual power supply. Since it is unlikely that a single trouble in the console will affect both power supplies number 1 and number 2 and their associated control circuits, the repair procedures are based on the assumption that only one power supply and/or its associated control circuits is malfunctioning. If neither power supply is operative, check switch S6201 on the dual power supply and check the primary power, 115 VAC, to the console.

(1). CONTROL CIRCUITS

The following procedure is applicable specifically for checking and isolating trouble in the control circuits associated with power supply number 1. With appropriate substitutions in the reference designations of components, terminals, etc., the same procedure is applicable to the control circuits associated with power supply number 2.

(a). With switch S6201 on the dual power supply in the off position, connect a temporary jumper around blocking diode CR6001. The purpose of the jumper is to connect 28 VDC from power supply number 2 to the control circuits of power supply number 1.

(b). Remove plug P6201 from jack J6201 on the dual power supply.

(c). Turn on switch S6201 on the dual power supply and depress switch S6004 on the acquisition data panel. Power supply number 2 is energized and 28 VDC is applied to the control circuits of power supply number 1. If the power supply number 1 control circuits are functioning properly, the green indicator lamps in switch S6003 on the acquisition data panel will be lit, and the switch when depressed will stay depressed, connecting 115 VAC to pins A and B of plug P6201 (measure with a voltmeter). Failure to perform as described indicates that the trouble is in the control circuits; proceed as follows to isolate the trouble.

(d). With a voltmeter measure the voltage across zener diode CR6003. It should be 18 1 VDC; if it is not, the diode is defective.

(e). Check the coil and contacts of relay K6001. The coil should have a d-c resistance of 1000 ohms. The contacts can conveniently be checked by measuring the voltage drop across each pair that should be closed; there should of course be no voltage across closed contacts.

(f). Check the coil, contacts, and indicator lamps in switch S6003. The coil should have a d-c resistance of 480 ohms. Check the contacts for voltage drop across each pair that should be closed.

(2). DUAL POWER SUPPLY

(a). ADJUSTMENT

The individual power supplies in the dual power supply should be adjusted so that at the maximum normal load imposed by the console and with the prevailing a-c line voltage input to the console; the output of each power supply onto the console 28 VDC bus is as close as possible to 25 VDC. With a given a-c line voltage, a d-c output voltage within the range of 24 to 26 VDC normally should be obtainable. If only the extremes of this range can be obtained, the output voltage should be set at the higher end of the range. Also, the power supplies should be adjusted so that with extremes of line voltage fluctuation and with d-c load variations from minimum to maximum, the d-c voltage output of the dual power supply is in no case greater than 30 VDC or less than 22.5 VDC. Voltages greater than 30 VDC are likely to overheat and thus damage the color filters in the console indicators, and any voltage less than 22.5 VDC may not be sufficient to operate the power supply control circuits. The curves of figures 5-10 and 5-11 are provided for reference in case it is necessary to adjust the power supplies with an a-c line voltage other than the prevailing one or with loads which differ appreciably from the normal maximum. The curves of figure 5-10 include the effects of the power supply control circuits and, therefore, apply when the dual power supply is in the console and voltages are measured on the console 28 VDC bus. The curves of figure 5-11 apply when the control circuits are disconnected and voltages are measured right at the output of a filter unit (terminal board TB6203 or TB6204, terminals 3 and 2), as when the dual power supply is on the bench. For an a-c line voltage near 115 VAC, transformer secondary connections to terminal board terminals 2 and 4 should provide the proper d-c output voltage. (The maximum normal load is approximately one ampere.) For other a-c line voltages, the curves of figures 5-10 and 5-11 show the transformer secondary connections which should produce the correct output voltage. Proceed as follows to check and adjust the power supply output voltages when the dual power supply is connected to the console for normal operation. The procedure for checking and adjusting when the dual power supply is on the bench is essentially the same as the following, but the details of the on-the-bench procedure will depend on the particular test setup used:

1. Energize power supply number 1 by turning on switch S6201 on the dual power supply and depressing "28V SUPPLY" switch S6003.

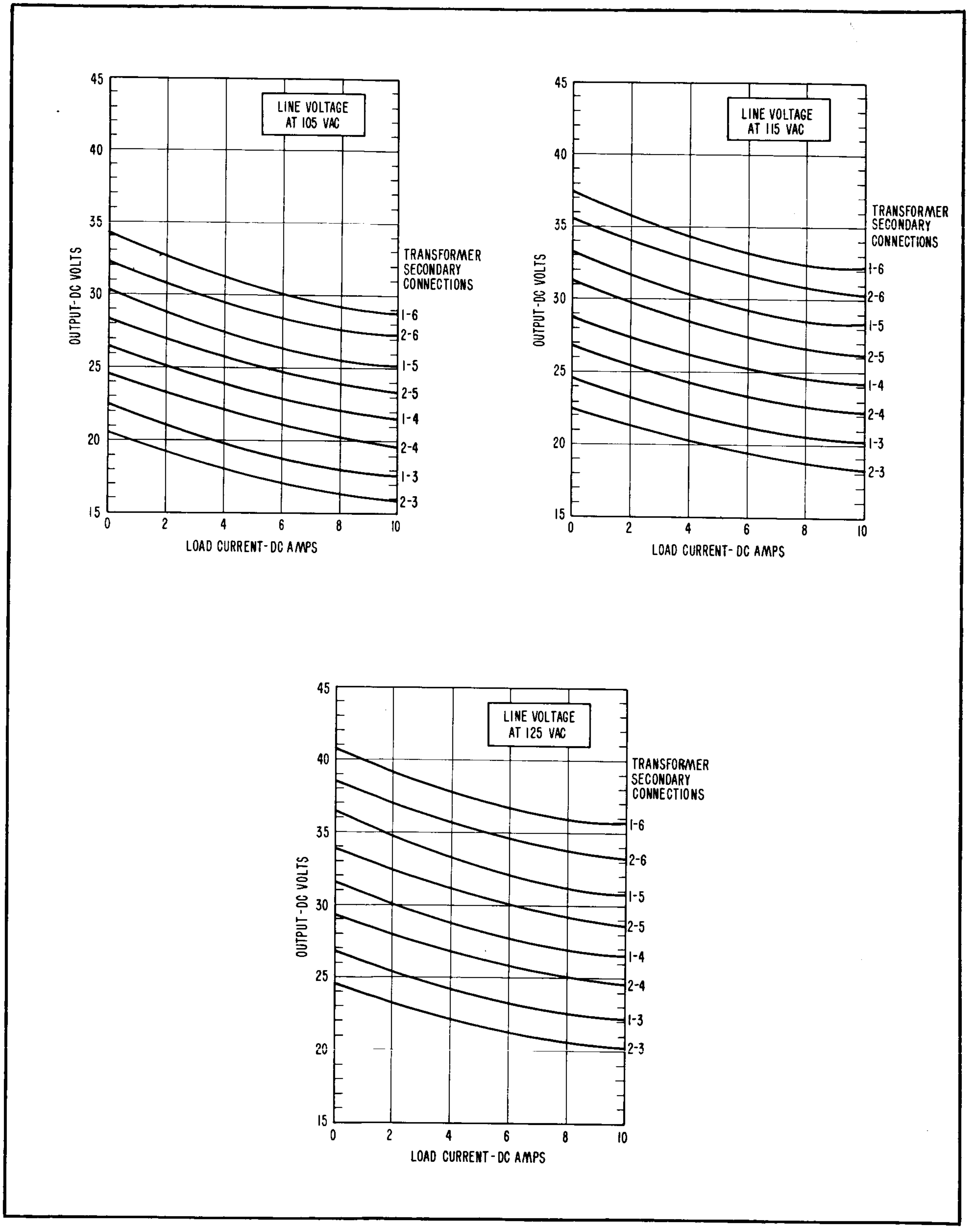



**Figure 5-10. Power Supply and Control Circuit Output Voltage versus Load Current Characteristics**

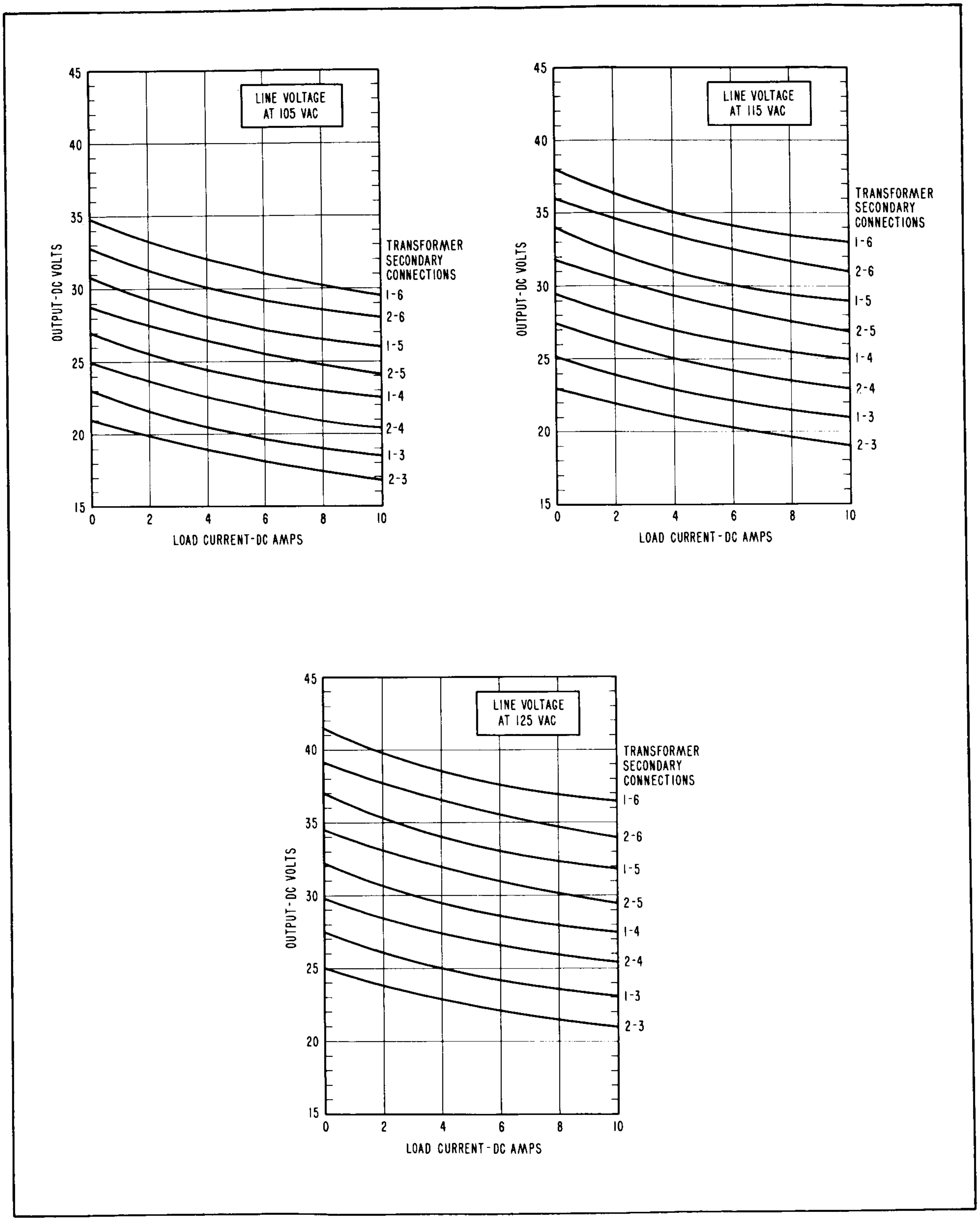



Figure 5-11. Power Supply Output Voltage versus Load Current Characteristics with Control Circuit Disconnected

2. Apply maximum normal load to the power supply by energizing as many switches, indicators, and relays as can be energized at one time.

3. Measure the voltage output of power supply number 1 on terminal board TB6001 or any other convenient place on the console 28 VDC bus. (See figure 7-1.)

4. The output voltage of the power supply should be as described above (24 to 26 volts with the prevailing a-c line voltage supplied to the console). If it is not, adjust the voltage by changing on terminal board TB6201 the connections to the secondary taps of transformer T6201. By changing these connections, the d-c output voltage of the power supply can be adjusted over a range of about 14 volts in steps of approximately two volts. Moving one connecting wire between TB6201 terminals 3 and 4, 4 and 5, or 5 and 6 increases or decreases the d-c output by about four volts; and moving the other connecting wire between TB6201 terminals 1 and 2 increases or decreases the output voltage by about two volts. (See figure 5-12.)

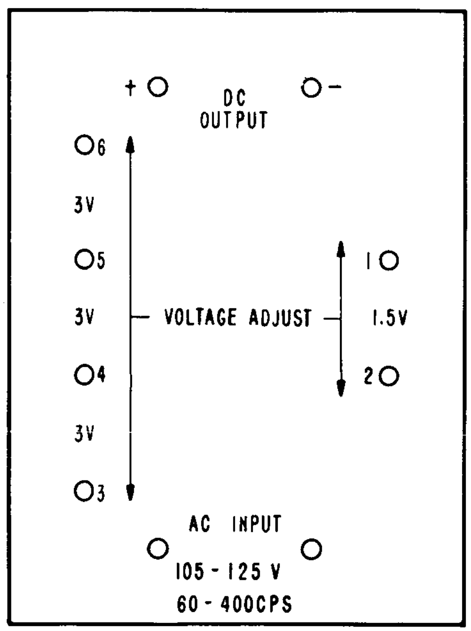



Figure 5-12. Power Supply Unit Terminal Board

5. Turn off power supply number 1 and repeat steps 1. through 4. with appropriate changes in reference designations for power supply number 2.

(b). <u>REPAIR</u>

Correction of a malfunction in the dual power supply can be affected by conventional trouble shooting and repair procedures. Check a-c and d-c voltages and check continuity of power transformer T6201 or T6202 and filter choke L6201 or L6202. See the dual power supply schematic and physical wiring diagrams, figures 7-3 and 7-4. For location of parts on the power supply units and filter units, see figure 5-13. Normal a-c voltages for the power transformers are shown in table 5-II. Bear in mind that two switches are in series with the primary 115 VAC power to each power supply in the dual power supply; for power supply number 1 these switches are S6201 on the dual power supply and S6003 on the acquisition data panel; for power supply number 2 the switches are S6201 on the dual power supply and S6004 on the acquisition data panel. Bear in mind also that in addition to the fuses, F6201 — F6204, on the front panel of the dual power supply, there is another fuse (F6205, F6206) on each of the power supply units (PS6201 and PS6202).

TABLE 5-II. NORMAL POWER TRANSFORMER VOLTAGES (T6201, T6202)

| Terminal Number TB6201 or TB6202 | Approximate RMS Voltage |
|---|---|
| 1-6 | 28 |
| 2-3 | 18 |
| 1-2 | 1.5 |
| 3-4 | 3 |
| 4-5 | 3 |
| 5-6 | 3 |
| 7-8 | 115 |

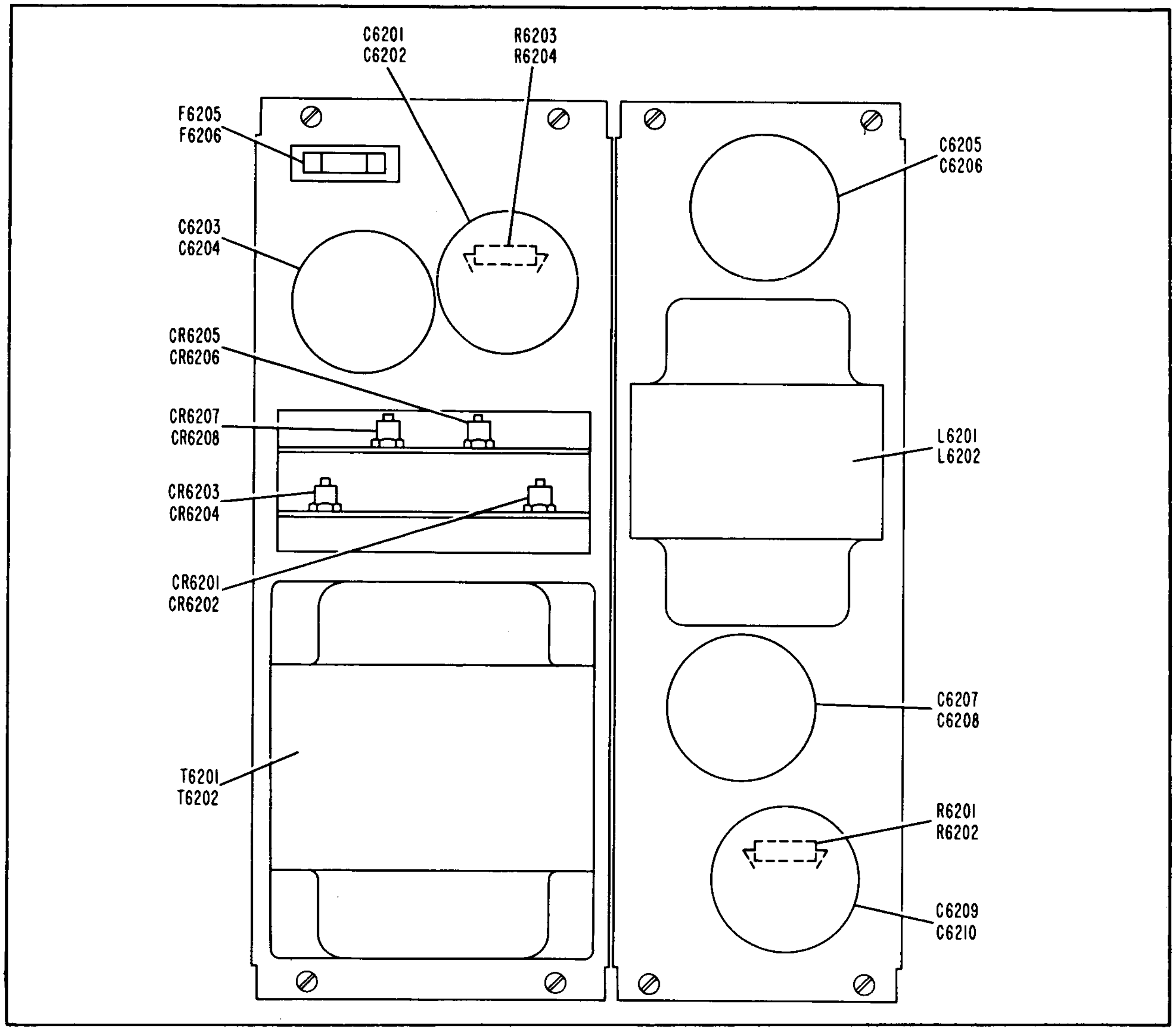



Figure 5-13. Power Supply Unit and Filter Unit, Parts Locations

E. RELAYS

(1). All of the relays used on the acquisition data consoles are hermetically sealed, and no maintenance or repair is possible. When one of them becomes defective, replace it. To ascertain that a console relay is defective, check the following:

(a). Coil resistance: D-c coil resistances should be as follows:

1. K1, K2: 1000 ohms.
2. K3, K4: 200 ohms.

(b). Contacts: With all power off, check continuity between normally closed contacts. With the suspected relay energized and voltage applied across the contacts, check for voltage drop across normally-open contacts. There should, of course, be none.

(2). For detailed information on relays in the acquisition system outside the acquisition data console, see the applicable equipment manuals.

F. SWITCH AND INDICATOR ASSEMBLIES

For a description of acquisition data console switch and indicator assemblies and how they work, refer to paragraph 4-2. B. (3). and figure 4-5.

(1). INDICATORS AND OPERATOR-INDICATOR UNITS

Maintenance of indicators and the operator-indicator unit portion of switch assemblies consists simply of replacing loose or defective lamps and color filters. Replacement of these items is most easily accomplished with the use of the special lamp-filter tool shown in figure 5-18. (Microswitch part number 15PA19.)

(2). COILS

The coil portion of switch assemblies can best be checked by observing the action of the plunger. When the plunger is depressed and the coil energized, the plunger should remain securely in the depressed, or actuated, position. Also check the d-c resistance of the coil. It should be about 480 ohms.

(3). SWITCHES

The operation of the switch portion of switch assemblies can be checked by seeing whether all of its contacts make and break properly as the coil plunger is depressed and released. Faulty or intermittently faulty operation of a switch section can often be corrected by adjusting the amount of bend in the small arm which actuates the individual switch section plunger (as distinguished from the main, or coil plunger). When the operation of a switch section is faulty and cannot be corrected, the entire switch portion of the switch assembly must be replaced.

G. SIGNAL STRENGTH METER CALIBRATION

To calibrate each of the signal strength meters on the acquisition data console signal strength meter panel, proceed as follows:

(1). Connect an r-f signal generator to the telemetry receiver with which the meter to be calibrated is associated. (Refer to the Telemetering System Manual, MS-106, for further information on the signal generator and telemetry receiver.)

(2). With telemetry receiver in operating condition and the signal generator frequency set at the operating frequency of the receiver, adjust the signal generator output level to 100 microvolts.

(3). Adjust signal strength meter CALIBRATION CONTROL R1, R2, R3 or R4 (figure 3-4) until the meter with which it is associated indicates 100 microvolts.

H. AUDIO AMPLIFIER

(1). ADJUSTMENT

No adjustment of the audio amplifier is required.

(2). REPAIR

(a). Since the circuitry of the audio amplifier is conventional and simple, ordinary trouble shooting techniques may be employed to correct malfunctions in it. When the amplifier is working properly, a signal of approximately four millivolts, 1000 cycles applied at TB1-2 is sufficient to drive output stage V3 into saturation. The test setup needed to obtain a four-millivolt signal with a Hewlett-Packard 200 CD wide range oscillator (audio signal generator) is shown in figure 5-14. A four-millivolt signal into the amplifier when it is operating normally produces an uncomfortably loud output from the speaker; therefore, it may be desirable to switch the speaker off while making checks. Switching the speaker off connects a five-ohm resistive load (R8 and R12) in place of the speaker and therefore does not alter the operating characteristics of the amplifier.

(b). Figures 5-15 and 5-16 are terminal voltage and terminal resistance diagrams of the audio amplifier when it is in good working order. The values given on figure 5-15 with a four-millivolt signal applied are those obtained with the test setup as shown in figure 5-14. The information on these diagrams should enable the technician quickly and easily to isolate and correct a malfunction in the amplifier.

(c). For location of parts on the audio amplifier, see figure 5-17.

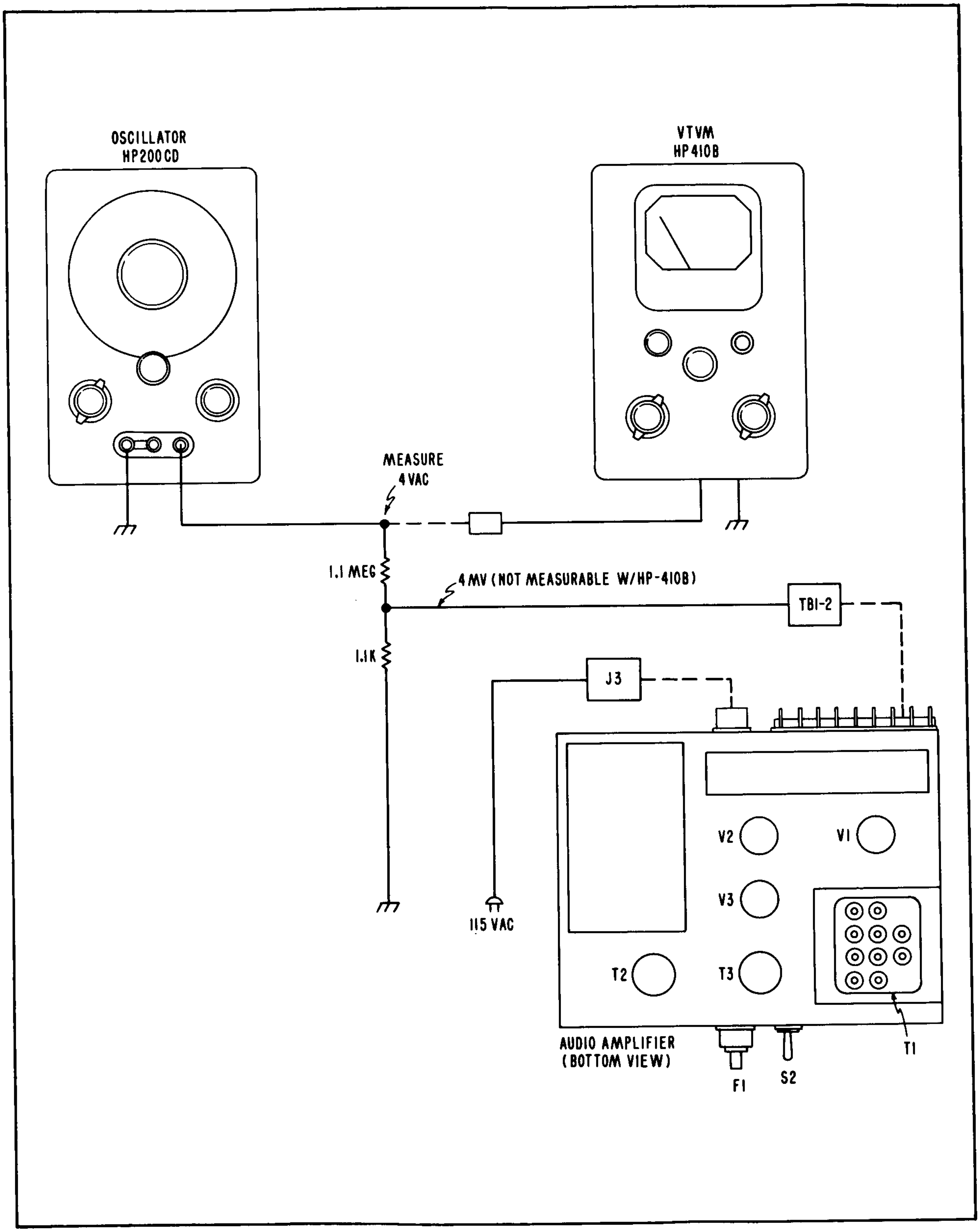
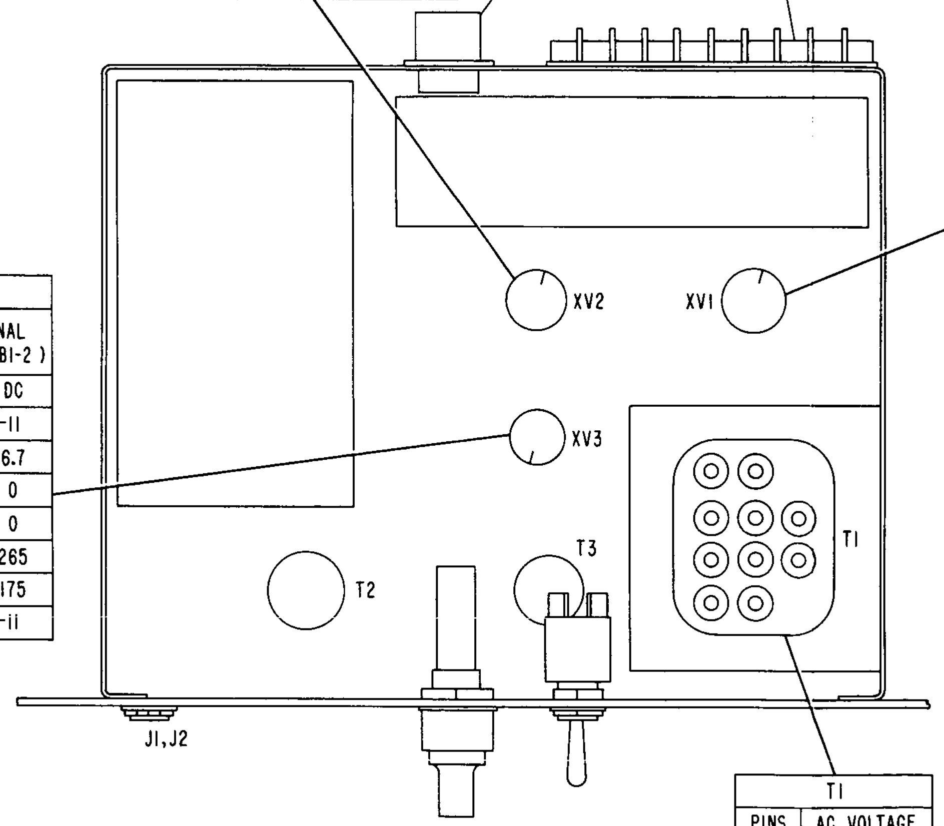



Figure 5-14. Audio Amplifier, Test Setup

| PIN | V2 (5751) NO SIGNAL * AC | DC | 4MV SIGNAL (APPLIED TO TB1-2) AC | DC |
|---|---|---|---|---|
| 1 | 0 | 52 | .7 | 48 |
| 2 | 0 | 0 | - | 0 |
| 3 | 0 | .9 | - | .9 |
| 4 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 |
| 6 | 0 | 100 | 13.5 | 110 |
| 7 | 0 | 0 | .7 | -.6 |
| 8 | 0 | .9 | 1.3 | .75 |
| 9 | 6.3 | 0 | 6.3 | 0 |

| PIN | V3 (6AQ5) NO SIGNAL * AC | DC | 4MV SIGNAL (APPLIED TO TB1-2) AC | DC |
|---|---|---|---|---|
| 1 | .3 | 0 | 13.5 | -11 |
| 2 | 0 | 7.8 | 0 | 6.7 |
| 3 | 6.3 | 0 | 6.3 | 0 |
| 4 | 0 | 0 | 0 | 0 |
| 5 | 6.6 | 255 | 140 | 265 |
| 6 | 0 | 185 | 0 | 175 |
| 7 | .3 | 0 | 13.5 | -11 |

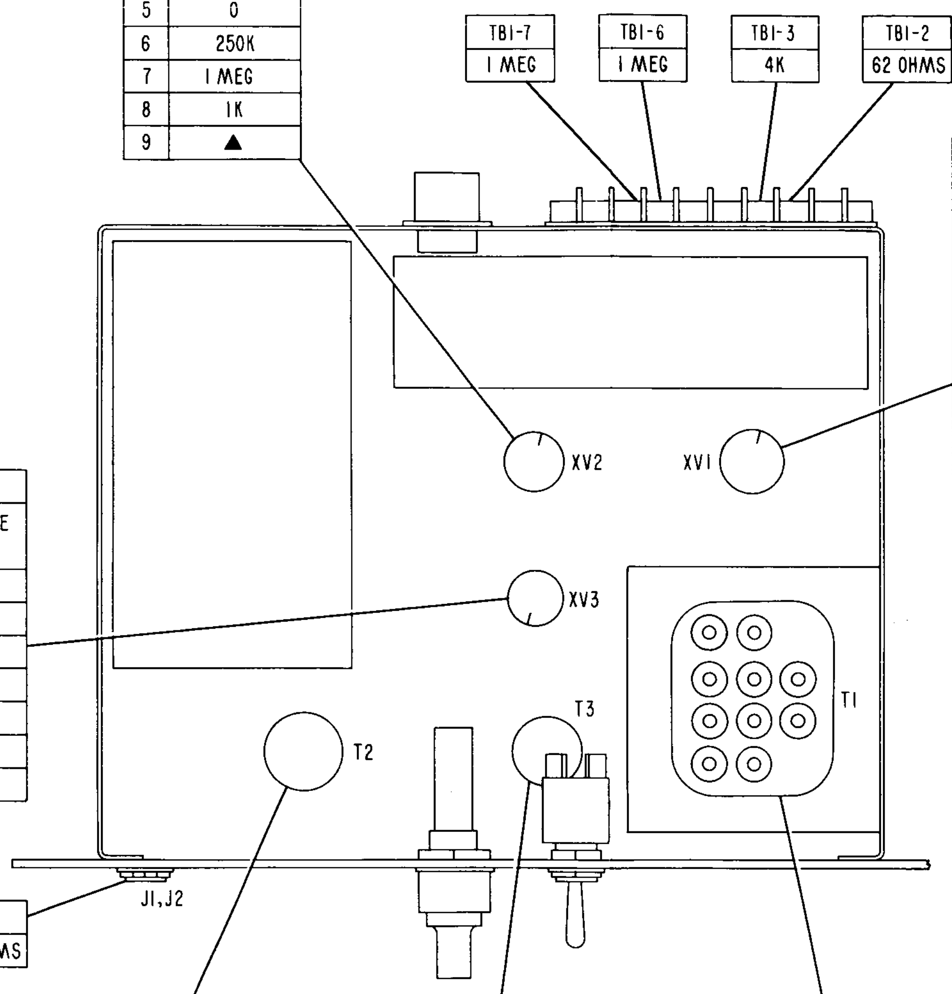



| PIN | V1 (6203) NO SIGNAL * AC | DC | 4MV SIGNAL (APPLIED TO TB1-2) AC | DC |
|---|---|---|---|---|
| 1 | 225 | -5 | 225 | -4.6 |
| 2 | - | - | - | - |
| 3 | - | - | - | - |
| 4 | - | - | - | - |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7 | 5.5 | 280 | 5.5 | 290 |
| 8 | - | - | - | - |
| 9 | 225 | -5 | 225 | -4.6 |

| T1 PINS | AC VOLTAGE |
|---|---|
| 1-2 | 115VAC |
| 3-5 | 450VAC CT |
| 6-8 | 6.3VAC CT |
| 9-10 | 5.0VAC |

NOTES:
1. VOLTAGES GIVEN ARE TYPICAL VALUES, MEASURED WITH A VTVM.
2. MEASUREMENTS ARE MADE WITH RESPECT TO CHASSIS GROUND.
3. VOLTAGES ARE POSITIVE EXCEPT WHERE INDICATED.
4. LINE INSIDE TUBE SOCKET DENOTES "KEYWAY".
5. IF DESIRED, SPEAKER SWITCH S1 MAY BE TURNED TO "OFF".
6. CONDITIONS:
   A. VOLUME CONTROL ON ACQUISITION DATA CONSOLE PANEL FULLY CLOCKWISE.
   B. LINE POWER CONNECTED TO J3 (115VAC).
   C. SWITCH S2 IN THE "ON" POSITION.
   D. * INDICATES TB1-2 GROUNDED TO CHASSIS FOR VOLTAGE CHECK WITH NO SIGNAL APPLIED.
   E. 4MV, 1000CPS SIGNAL APPLIED TO TB1-2 FOR VOLTAGE CHECK WITH SIGNAL APPLIED.

Figure 5-15. Audio Amplifier, Terminal Voltage Diagram




| V2 (5751) | |
|---|---|
| PIN | RESISTANCE OHMS |
| 1 | 620K |
| 2 | 4K |
| 3 | 3.3K |
| 4 | 0 |
| 5 | 0 |
| 6 | 250K |
| 7 | 1 MEG |
| 8 | 1K |
| 9 | ▲ |

| V1 (6203) | |
|---|---|
| PIN | RESISTANCE OHMS |
| 1 | 250* |
| 2 | ∞ |
| 3 | ∞ |
| 4 | ∞ |
| 5 | ∞ |
| 6 | ∞ |
| 7 | 172K |
| 8 | ∞ |
| 9 | 250* |

| V3 (6AQ5) | |
|---|---|
| PIN | RESISTANCE OHMS |
| 1 | 150K |
| 2 | 220 |
| 3 | ▲ |
| 4 | 0 |
| 5 | 172K |
| 6 | 150K |
| 7 | 150K |

| J1 | J2 |
|---|---|
| 32 OHMS | 32 OHMS |

| T2* | |
|---|---|
| PINS | DC RESISTANCE |
| 1-2 | 10 |
| 2-3 | 20 |
| 3-4 | 0 |
| 1-3 | 30 |
| 4-5 | 20 |
| 5-6 | 10 |
| 1-6 | 60 |
| 6-7 | 0 |
| 7-8 | 4K |

| T3* | |
|---|---|
| PINS | DC RESISTANCE |
| 1-2 | 230 |
| 2-3 | — |
| 3-4 | ▲ |
| 4-5 | ▲ |
| 5-6 | ▲ |
| 6-7 | 20 |
| 7-8 | 12 |
| 3-8 | 33 |
| 4-8 | 32 |

| T1* | |
|---|---|
| PINS | DC RESISTANCE |
| 1-2 | 12 |
| 2-3 | ∞ |
| 3-4 | 250 |
| 4-5 | 250 |
| 3-5 | 500 |
| 5-6 | ∞ |
| 6-7 | ▲ |
| 7-8 | ▲ |
| 8-9 | ∞ |
| 9-10 | ▲ |

NOTES:

1. RESISTANCES GIVEN ARE TYPICAL VALUES.
2. MEASUREMENTS ARE TAKEN TO CHASSIS GROUND.
3. RESISTANCE READINGS ARE IN OHMS, K=1000, MEG=1,000,000, ∞=INFINITY.
4. LINE INSIDE TUBE SOCKET DENOTES "KEYWAY".
5. TRANSFORMER MEASUREMENTS ARE PIN TO PIN DC RESISTANCES.
6. ▲ INDICATES VALUES TO SMALL TO READ WITH METER.
7. CONDITIONS:
   A. VOLUME CONTROL ON ACQUISITION DATA CONSOLE PANEL FULLY CLOCKWISE.
   B. NO EXTERNAL LEADS CONNECTED.
8. * INDICATES VALUES TAKEN WITH UNIT AT ROOM TEMPERATURE.

Figure 5-16. Audio Amplifier, Terminal Resistance Diagram

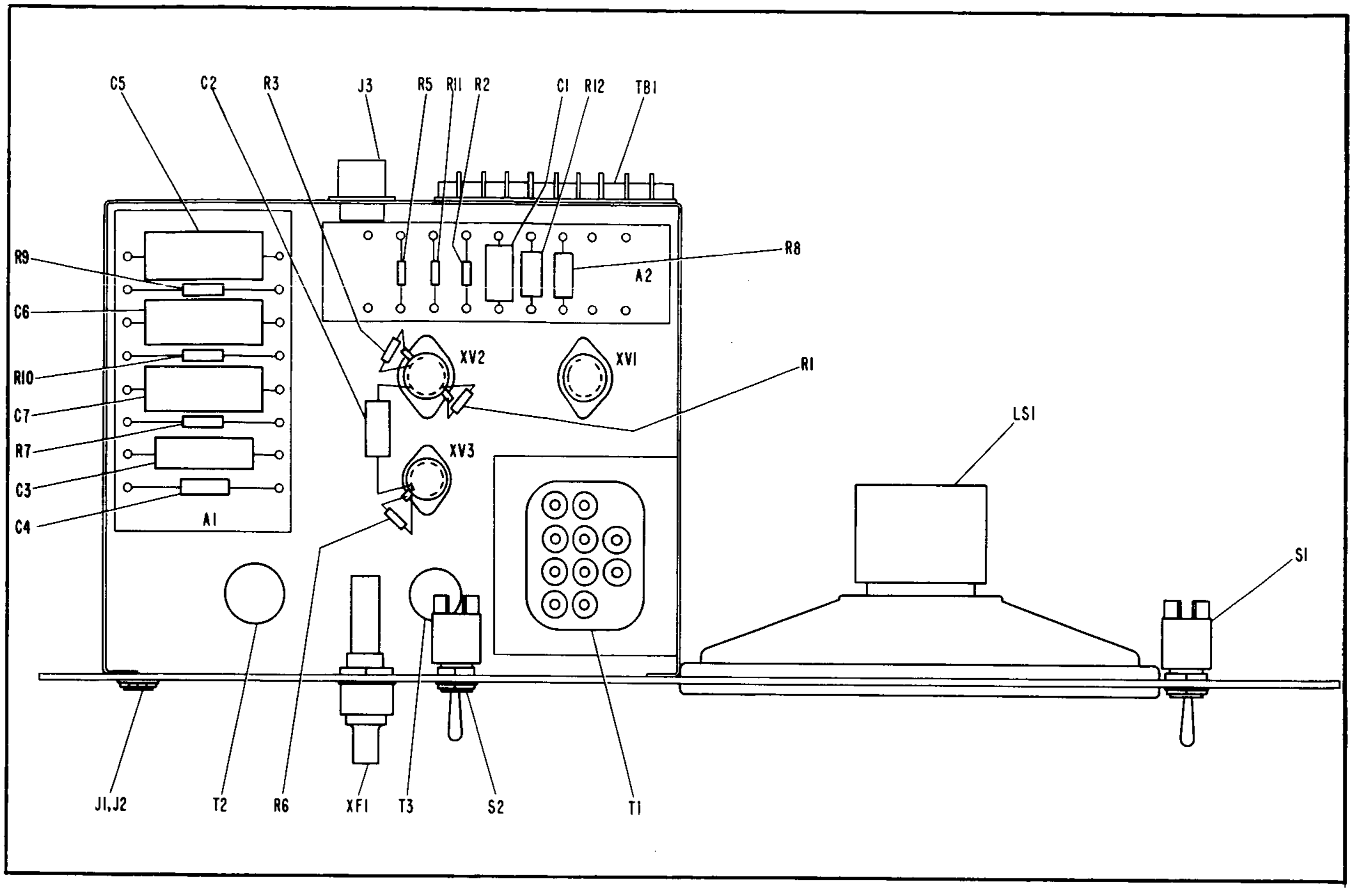



Figure 5-17. Audio Amplifier, Parts Location

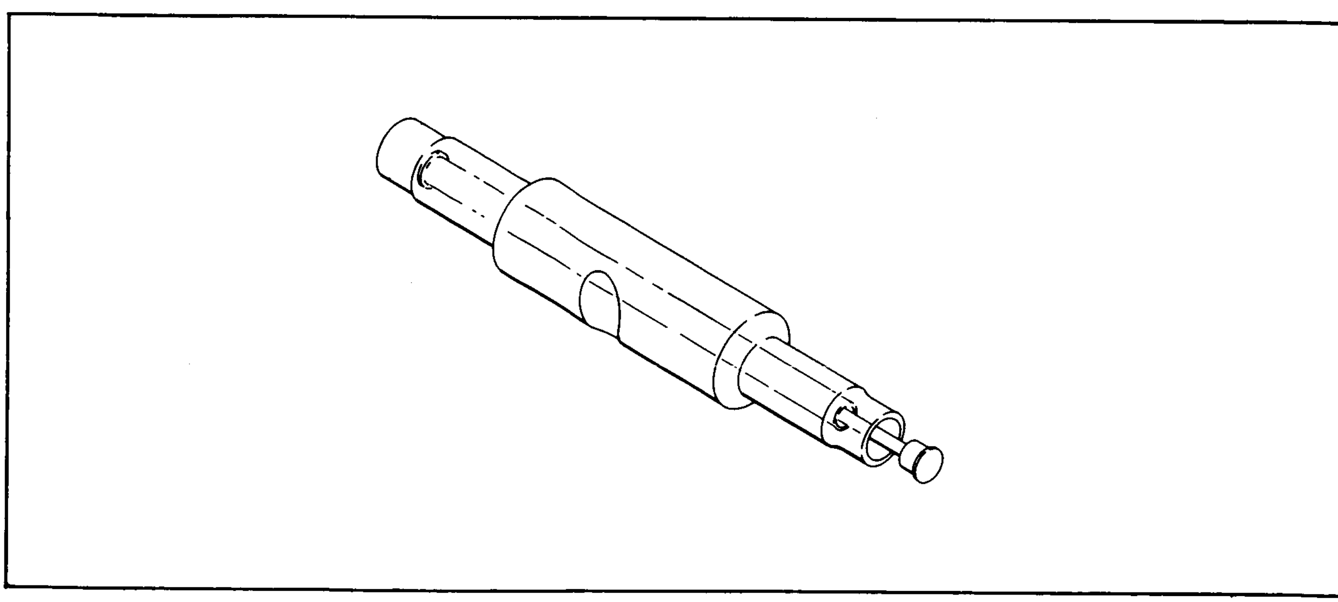


Figure 5-18. Lamp-Filter Tool

5-5. LUBRICATION

Table 5-III is a lubrication schedule for all of the equipment in the acquisition system.

5-6. SPECIAL TOOLS

The only special tool required for maintenance of the acquisition system is the lamp-filter tool (Microswitch part number 15PA19, Bendix Radio part number A683836-1). This tool, shown in figure 5-18, is used for removal and replacement of the lamps and color filters in the indicators and switch assemblies on the acquisition data console.

5-7. TEST EQUIPMENT

Each piece of test equipment required for maintenance of the acquisition system is listed in table 5-IV along with a brief description of its application.

TABLE 5-III. LUBRUCATION SCHEDULE

| Lubrication Point | Procedure | Lubricant | Frequency |
|---|---|---|---|
| ACQUISITION DATA CONSOLE | | | |
| No lubrication required. | — | — | — |
| ACTIVE ACQUISITION AID | | | |
| Muffin fans in RF housing | Lubricate with one or two drops of oil. Refer to equipment manual. | Aero Shell No. 12 (MIL-L-6085) | Monthly |

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS

| Equipment | Manufacturer | Model | Application |
|---|---|---|---|
| Universal EPUT and Timer | Beckman Instruments, Incorporated | 7370 | Precision frequency measurements from 10 CPS to 11.5 MC. |
| Frequency Converter | Beckman Instruments, Incorporated | 7570 through 7573 | Used with Beckman EPUT and timer to measure frequencies up to 220 MC. |
| Field Strength Meter | Empire Devices Products Corporation | NF-105 (Bendix Part No. A683351) | Noise figure measurements in the 150-KC to 400-MC frequency range. |
| Power Output Meter | The Daven Company | OP-962 | Audio frequency power measurements in the power range of 0.1 milliwatt to 100 watts. |
| Potentiometric DC Voltmeter | John Fluke Manufacturing Company, Incorporated | 801 | Precision d-c measurements with .05 per cent accuracy over the range of .01 to 500 volts. |
| Vacuum Tube Voltmeter | Hewlett-Packard Company | 410B | General a-c, d-c, and r-f voltage measurements and resistance measurements. |
| Vacuum Tube Voltmeter | Hewlett-Packard Company | 400D | Accurate a-c voltage measurements from .001 volt to 300 volts over a frequency range of 10 cycles to 4 megacycles. |
| Volt-Ohm-Milliammeter | Triplett-Electrical Instrument Company | 630-PL | General voltage, current and resistance measurements (20,000 ohms/volt). |
| Noise and Distortion Analyzer | Hewlett-Packard Company | 330B | Measure total distortion of any frequency from 20 to 20,000 CPS. |
| RF Detector | Telonic Industries, Incorporated | XD-3 | Detect output of r-f preamplifiers and i-f amplifiers in the 0.5- to 1000-MC range. |
| Tube Analyzer | Triplett Electrical Instrument Company | 3444 | Tube checks. |

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

| Equipment | Manufacturer | Model | Application |
|---|---|---|---|
| Unit Regulated Power Supply | General Radio Company | 1201-B | General bench testing of assemblies. Provides a source of AC heater voltage at 6.3 VAC and 4A, and DC plate power at 300 VDC and 70 MA. |
| Regulated Power Supply | Lambda Electronics Corporation | 71 | General purpose power supply with following outputs: 0-500 VDC, 0-200 MA; 0-200 VDC, 0-50 VDC, Bias; and 6.5 VAC, 5A. |
| DC Power Supply | John Fluke Manufacturing Company, Incorporated | 407 | High resolution power supply with output of 0 to 555 volts and 0 to 300 MA for calibration purposes. |
| Square Wave Generator | Tektronix, Incorporated | Type 105 | Alignment and testing of oscilloscopes and associated plug-in units. |
| Signal Generator | Boonton Radio Corporation | 225-A | Test and alignment of receivers, sensitivity and bandwidth measurements in the 10- to 500-MC frequency range. |
| Sweep Generator | Telonic Industries, Incorporated | HN-3 | Testing and adjusting r-f circuits in the frequency range of 0.5 to 300 MC. |
| HF Signal Generator | Hewlett-Packard Company | 606-A | General purpose signal generator with a frequency range of 50 KC to 65 MC. |
| Function Generator | Hewlett-Packard Company | 202-A | Test and adjustment of circuits which handle non-sinusoidal waveshapes. |
| Transfer Oscillator | Hewlett-Packard Company | 540-B | Test and alignment of signal generators up to 2000 MC. |
| Wide Range Oscillator | Hewlett-Packard Company | 200 CD | Test and adjustment of circuits in the range of 5 CPS to 600 KC. |
| Unit Oscillator | General Radio Company | 1209-BL | Test and alignment of receivers, sensitivity and bandwidth measurements in the 180- to 600-MC range. |

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

| Equipment | Manufacturer | Model | Application |
|---|---|---|---|
| Oscilloscope | Hewlett-Packard Company | 130B | General waveform observation and voltage measurements. |
| Oscilloscope | Tektronix, Incorporated | 545A | General waveform observation and voltage measurements. |
| Dual-Trace Calibrated Preamp | Tektronix, Incorporated | Type CA | Oscilloscope plug-in unit used with Tektronix 545A. |
| Plug-In Preamplifier | Tektronix, Incorporated | Type L | Oscilloscope plug-in unit used with Tektronix 545A. |
| Viewing Hood | Tektronix, Incorporated | H510 | Aid in viewing of oscilloscope screens. |
| Oscilloscope Cart | Technibilt Corporation | OC-2 (Bendix Radio-Part A683940-2) | Support and transportation of oscilloscopes. |
| Oscilloscope Cart | Technibilt Corporation | OC-2 (Bendix Radio-Part A683940-1) | Support and transportation of oscilloscopes and storage of plug-in units. |
| Variac | General Radio Company | W10MT | General purpose voltage source with output of 0-115 VAC at 10 amps. |
| Attenuator Pad | Telonic Industries, Incorporated | TGC-50 | Matching, isolation, and general bench test applications in the 0.5- to 1000-MC frequency range. |
| Miscellaneous Cables and Accessories | — | — | — |

# SECTION VI
# PARTS LIST

## 6-1. GENERAL

This section comprises lists of the parts which make up the acquisition data console. These lists are as follows:

| Equipment | Parts List Table | Parts Location Illustration |
|---|---|---|
| Acquisition Data Console, P/N R651498-4, -5, -6 | 6-I | Figure 7-2 |
| Dual Power Supply P/N R651470-2 | 6-II | Figures 7-4, 5-13 |
| Audio Amplifier, P/N 653716-1 | 6-III | Figure 5-17 |
| Intercom Cabinet Assembly, P/N N651474-1, -2 | 6-IV | - |
| Miscellaneous Items | 6-V | - |

## 6-2. OTHER EQUIPMENT

For information on other equipment in the acquisition system, refer to the applicable equipment manuals, listed in table 1-II.

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N R651498-4, -5, -6

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| B6001 | Synchro Receiver | N681819-3 | - | 1 |
| B6002 | Synchro Receiver | N681819-2 | - | 1 |
| B6003 | Synchro Receiver | N681819-3 | - | 1 |
| B6004 | Synchro Receiver | N681819-2 | - | 1 |
| B6005 | Synchro Receiver | N681819-3 | - | 1 |
| B6006 | Synchro Receiver | N681819-2 | - | 1 |
| B6007 | Synchro Receiver | N681819-3 | - | 1 |
| B6008 | Synchro Receiver | N681819-2 | - | 1 |
| - | Synchro Transmitter Assembly: each consisting of: | N654986-1 | - | 2 |
| B6009, B6010 | Synchro Transmitter | N683953-1 | - | 1 |
| - | Spring, Compression | A689693-1 | - | 1 |
| - | Bushing, Polyamide | A689682-1 | - | 1 |
| - | Bushing, Polyamide | A689683-2 | - | 1 |
| CR6001, CR6002 | Diode, Silicon | A683966-1 | - | 2 |
| CR6003, CR6004 | Diode, Zener (18 volts) | A683971-1 | - | 2 |
| DS6001, through DS6010 | Lamp, Dialco #39 | A683817-3 | - | 4 |
| DS6011 through DS6038 | Lamp, GE327 | - | AN3140-327 | 28 |

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N R651498-4, -5, -6 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| K6001, K6002 | Relay, Sensitive 1000 ohm 4.5 ma (DPDT) | A683968-1 | - | 2 |
| K6003, K6004 | Relay, 28 VDC, 6PDT | A683969-3 | - | 2 |
| M6001 through M6004 | Microammeter, 0-50 $\mu$ amps | N683770-1 | - | 4 |
| P6001 through P6008 | Connector | - | MS3106A-14S-2S | 8 |
| R6001 through R6004 | Potentiometer, 500K | C219564-6 | - | 4 |
| R6005 through R6008 | Resistor, 240K, 1/2 w 5% | - | RC07GF244J | 4 |
| R6009 | Potentiometer, 1 Meg, 10% | - | RV4NAYSD105A | 1 |
| S6001 | Switch Assembly, consisting of: | - | - | - |
| - | Switch, 4PDT (momentary) | A681845-3 | - | 1 |
| - | Lamps, DS6025, DS6026 | - | - | 2 |
| - | Oper. Indicator Unit w/coil | A681843-3 | - | 1 |
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (yellow) | A683911-2 | - | 2 |
| S6002 | Switch Assembly, consisting of: | - | - | - |
| - | Switch, 4PDT (momentary) | A681845-3 | - | 1 |
| - | Lamps, DS6027, DS6028 | - | - | 2 |

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N R651498-4, -5, -6 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (yellow) | A683911-2 | - | 2 |
| S6003 | Switch Assembly, consisting of: | - | - | - |
| - | Switch, 3PDT (momentary) | A681845-4 | - | 1 |
| - | Lamps, DS6031, DS6032, DS6033, DS6034 | - | - | 4 |
| - | Oper. Indicator Unit w/coil | A681843-3 | - | 1 |
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| - | Color Filter (green) | A683911-3 | - | 2 |
| S6004 | Switch Assembly, consisting of: | - | - | - |
| - | Switch 3PDT (momentary) | A681845-4 | - | 1 |
| - | Lamps, DS6035, DS6036, DS6037, DS6038 | - | - | 4 |
| - | Oper. Indicator Unit w/coil | A681843-3 | - | 1 |
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| - | Color Filter (green) | A683911-3 | - | 2 |
| S6005 | Switch, Rotary | L218600-33 | - | 1 |
| T6001 | Transformer | A665085-1 | - | 1 |
| TB6001 | Terminal Board | L678289-8 | - | 1 |
| TB6002 through TB6017 | Terminal Board | L678288-8 | - | 16 |

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N R651498-4, -5, -6 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| X6001 | Indicator Unit | A683961-2 | - | 1 |
| - | Lamps DS6011, DS6012 | - | - | 2 |
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (yellow) | A683911-2 | - | 2 |
| X6002 | Indicator Unit | A683961-2 | - | 1 |
| - | Lamps DS6013, DS6014, DS6015, DS6016 | - | - | 4 |
| - | Display Screen | A681848-4 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| - | Color Filter (green) | A683911-3 | - | 2 |
| X6003 | Indicator Unit | A683961-2 | - | 1 |
| - | Lamps DS6017, DS6018, DS6019, DS6020 | - | - | 4 |
| - | Display Screen | A681848-4 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| - | Color Filter (green) | A683911-3 | - | 2 |
| X6004 | Indicator Unit | A683961-2 | - | 1 |
| - | Lamps DS6021, DS6022, DS6023, DS6024 | - | - | 4 |
| - | Display Screen | A681848-4 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| - | Color Filter (green) | A683911-3 | - | 2 |
| X6005 | Indicator Unit | A683961-2 | - | 1 |
| - | Lamps DS6029, DS6030 | - | - | 2 |

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N R651498-4, -5, -6 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| - | Display Screen | A681848-2 | - | 1 |
| - | Color Filter (red) | A683911-1 | - | 2 |
| XDS6001 through XDS6010 | Pilot Light Assembly | A683815-1 | - | 10 |
| XS6001 through XS6004 | Oper. Indicator Unit w/coil | A681843-3 | - | 4 |
| P6201 | Connector | - | MS3106R-18-12S | 1 |
| P6202 | Connector | - | MS3106R-20-7S | 1 |
| - | Handwheel | C294673-1 | - | 2 |
| - | Knob | C294634-1 | - | 2 |
| - | Telephone Jack, WECO P/N238A | A683777-1 | - | 5 |
| - | Audio Amplifier, Cubic Corp. P/N 18598-1 | 653716-1 | - | 1 |
| - | Dual Power Supply | R651470-2 | - | 1 |
| - | Barrier Strips (Used with Indicator Units and Switch Assemblies) | A681860-2 | - | 17 |
| - | Intercom Cabinet Assembly | N651474-1, -2 (N651474-1 at Canton Island, N651474-2 at Kano and Zanzibar) | - | 1 |

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| DS6201 | Lamp, NE-51 | C221315-1 | - | 1 |
| F6201 through F6204 | Fuse | C221603-502 | - | 4 |
| FL6201 | Filter, Dressen-Barnes Model 21-105 | A681997-1 | - | 1 |
| C6205 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| C6207 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| C6209 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| L6201 | Choke, Dressen-Barnes 512910 | - | - | 1 |
| R6201 | Resistor, ohmite, 600 ohm, 5W | - | - | 1 |
| FL6202 | Filter, Dressen-Barnes Model 21-105 | A681997-1 | - | 1 |
| C6206 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| C6208 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| C6210 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| L6202 | Choke, Dressen-Barnes 512910 | - | - | 1 |
| R6202 | Resistor, Ohmite, 600 ohm, 5W | - | - | 1 |
| J6201 | Receptacle, Box | - | MS3102R-18-12P | 1 |
| J6202 | Receptacle, Box | - | MS3102R-20-7P | 1 |
| PS6201 | Power Supply, Dressen-Barnes Model 21-103 | A681999-3 | - | 1 |
| C6201 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |
| C6203 | Capacitor, 50 WVDC, 4000 $\mu$f | - | - | 1 |

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| CR6201 | Diode, 1N2129, International Rectifier Type X25HB10 | - | - | 1 |
| CR6203 | Diode, 1N2129, International Rectifier Type X25HB10 | - | - | 1 |
| CR6205 | Diode, 1N2129, International Rectifier Type X25HB10 | - | - | 1 |
| CR6207 | Diode, 1N2129, International Rectifier Type X25HB10 | - | - | 1 |
| F6205 | Fuse, 10 amp. | - | - | 1 |
| T6201 | Transformer, Dressen-Barnes 511721 | - | - | 1 |
| PS6202 | Power Supply, Dressen-Barnes Model 21-103 | A681999-3 | - | 1 |
| C6202 | Capacitor, 50 WVDC 4000 $\mu$f | - | - | 1 |
| C6204 | Capacitor, 50 WVDC 4000 $\mu$f | - | - | 1 |
| CR6202 | Diode, 1N2129, International Rectifier Type X25HB10 | - | - | 1 |
| CR6204 | Diode, 1N2129, International Rectifier X25HB10 | - | - | 1 |
| CR6206 | Diode, 1N2129, International Rectifier X25HB10 | - | - | 1 |
| CR6208 | Diode, 1N2129, International Rectifier X25HB10 | - | - | 1 |
| F6206 | Fuse, 10 amp. | - | - | 1 |
| T6202 | Transformer, Dressen-Barnes 511721 | - | - | 1 |

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| XDS6201 | Light, Indicator | C221313-7 | — | 1 |
| XF6201 through XF6204 | Post, Fuse, 3 AG | A683967-1 | — | 4 |

TABLE 6-III. LIST OF REPLACEABLE ELECTRICAL PARTS FOR AUDIO AMPLIFIER P/N 653716-1

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| C1, C2 | Capacitor, .047 $\mu$f, 400V, ±10% | - | CP05AIEE473K | 2 |
| C3 | Capacitor, 25 $\mu$f, 50V, TVA 1306, Sprague | - | - | 1 |
| C4 | Capacitor, .022 $\mu$f, 200V, ±10% | - | CP05AIEC223K | 1 |
| C5, C6, C7 | Capacitor, 10 $\mu$f, 450V, TVA 1705, Sprague | - | - | 3 |
| F1 | Fuse, 1 Amp, 3 AG Buss | - | - | 1 |
| J1, J2 | Phone Jack, LS2-A, Mallory | - | - | 2 |
| J3 | Connector | - | MS3102A-10SL-4P | 1 |
| LS1 | Speaker, 57A21, Quam | - | - | 1 |
| R1 | Resistor, 3.3K, 1/2W, ±10% | - | RC20GF332K | 1 |
| R2 | Resistor, 470K, 1/2W, ±10% | - | RC20GF474K | 1 |
| R3 | Resistor, 1K, 1/2W, ±10% | - | RC20GF102K | 1 |
| R4 | Not Used | - | - | - |
| R5 | Resistor, 100K, 1/2W, ±10% | - | RC20GF104K | 1 |
| R6 | Resistor, 150K, 1/2W, ±10% | - | RC20GF154K | 1 |
| R7 | Resistor, 220Ω, 1W, ±10% | - | RC32GF221K | 1 |
| R8 | Resistor, 10Ω, 2W, ±10% | - | RC42GF100K | 1 |
| R9 | Resistor, 510Ω, 1W, ±10% | - | RC32GF511K | 1 |
| R10 | Resistor, 22K, 1W, ±10% | - | RC32GF223K | 1 |
| R11 | Resistor, 150K, 1/2W, ±10% | - | RC20GF154K | 1 |
| R12 | Resistor, 10Ω, 2W, ±10% | - | RC42GF100K | 1 |
| S1 | Switch, ST50N | - | - | 1 |

TABLE 6-III. LIST OF REPLACEABLE ELECTRICAL PARTS FOR AUDIO AMPLIFIER P/N 653716-1 (Cont.)

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| S2 | Switch, ST50N | - | - | 1 |
| T1 | Transformer, PHC-40, Chicago | - | - | 1 |
| T2 | Transformer, HS-1, TRIAD | - | - | 1 |
| T3 | Transformer, HS-73, TRIAD | - | - | 1 |
| TB1 | Terminal Board | L678008-2 | - | 1 |
| V1 | Electron Tube 6203 | - | - | 1 |
| V2 | Electron Tube 5751 | - | - | 1 |
| V3 | Electron Tube 6AQ5 | - | - | 1 |

TABLE 6-IV. LIST OF REPLACEABLE ELECTRICAL PARTS FOR INTERCOM CABINET ASSEMBLY P/N N651474-1, -2

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| DS6401 | Buzzer, WECO Part Number 7F-42 | A683505-1 | - | 1 |
| R6401 | Dual Potentiometer, WECO Part Number KS13754 | A683378-1 | - | 1 |
| Z6401 through Z6404 | Key | A683775-1 | - | 4 |
| DIAL (Note 1) | Telephone Dial, WECO Part Number 6L-41 | A683776-1 | - | 1 |
| | Knob | C294634-1 | - | 1 |
| | ASSOCIATED PARTS | | | |
| | Connector and Cable Assy. | A683548-1 | - | 4 |
| | Connector | A683542-1 | - | 1 |

Note 1: Dial is used only on N651474-1 (at Canton Island).

TABLE 6-V. LIST OF REPLACEABLE ELECTRICAL PARTS FOR MISCELLANEOUS ITEMS

| Reference Designation | Part Name and Description | Bendix Part No. | Part No. (MIL, JAN, or FSN) | Quan. |
|---|---|---|---|---|
| | Transformer, Step-up, 115 VAC pri; 480 VAC sec. | A665084-1 | - | 1 |
| | Transformer, Step-down, 480 VAC pri; 115 VAC sec. | A665085-1 | - | 2 |
| | Cutoff Switch and Warning Light Assy., consisting of: | L653858-1 | - | 1 |
| | Switch and Box, ERTA 12022 | A683229-1 | - | 1 |
| | Warning Light Assy. | A683135-1 | - | 1 |
| | Lamp, Incandescent | A120680-1 | - | 1 |
| | Cable | 689846-2 | - | - |

# SECTION VII
# MAINTENANCE DRAWINGS

## 7-1. GENERAL

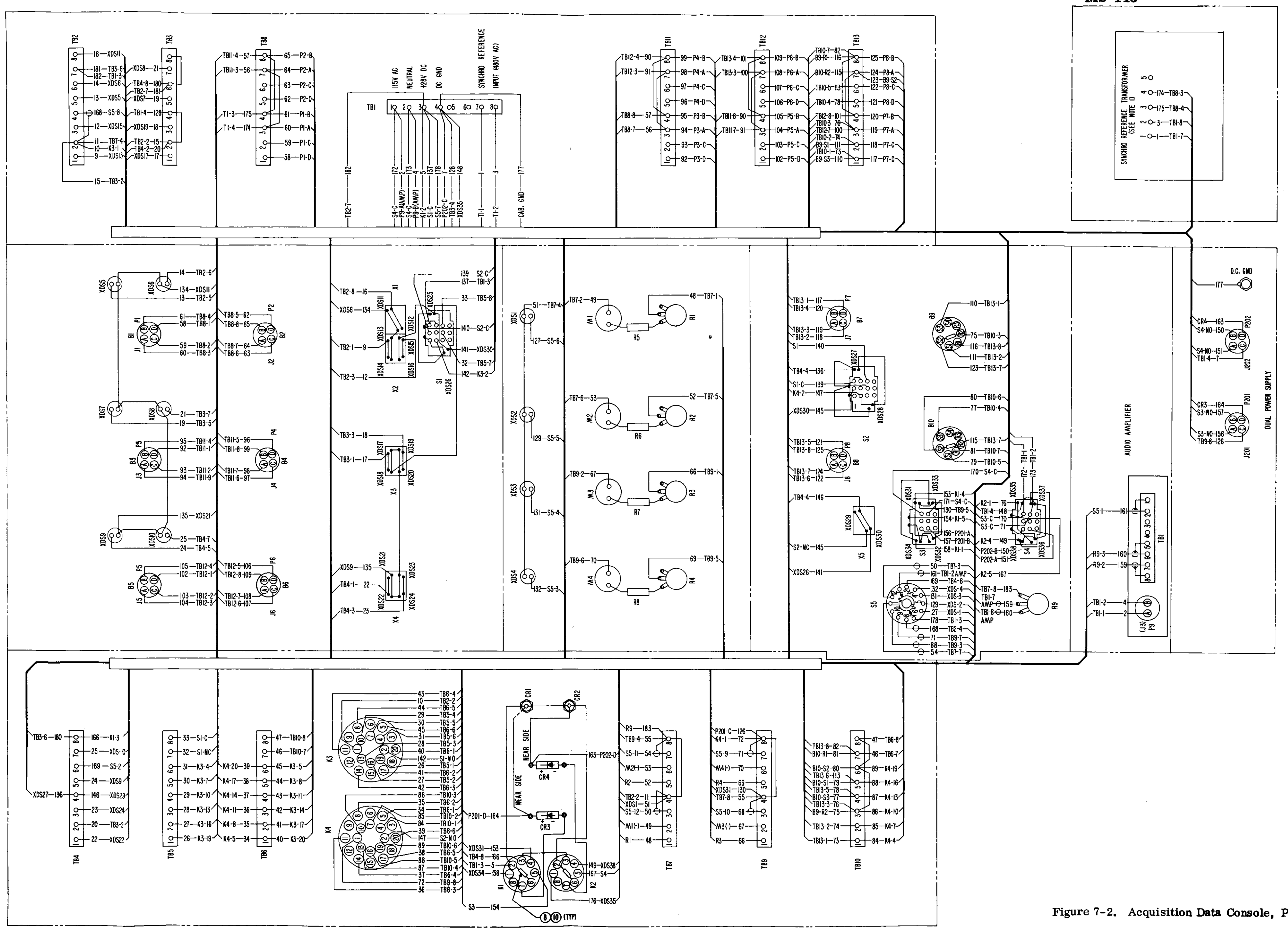
The drawings included in this section are listed below. It should be noted that those schematics which show connections or circuits involving two or more separate pieces of equipment are not in all cases complete in regard to the internal circuits of the equipment. For complete internal circuits, see the schematics of the individual pieces of equipment. The schematics of the individual pieces of equipment are included in this section or in the individual equipment manuals, listed in table 1-II.


NOTES—
1. ADD 6000 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT EXCEPT AUDIO AMPLIFIER.
2. REAR VIEW OF SWITCHES S1 THROUGH S4.

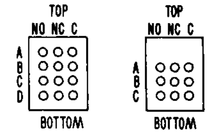
(TYPICAL)

3. ALL SWITCHES AND RELAYS SHOWN IN UNENERGIZED POSITION.
4. DESIGNATIONS A1, A2, B1 AND B2 ARE DERIVED AS FOLLOWS:
A-TELEMETRY FREQUENCY A.
B-TELEMETRY FREQUENCY B.
1-RECEIVING ANTENNA (AND TELEMETRY RECEIVERS CONNECTED TO IT.)
2-AAA ANTENNA (AND TELEMETRY RECEIVERS CONNECTED TO IT.)

Figure 7-1. Acquisition Data Console, Schematic Diagram

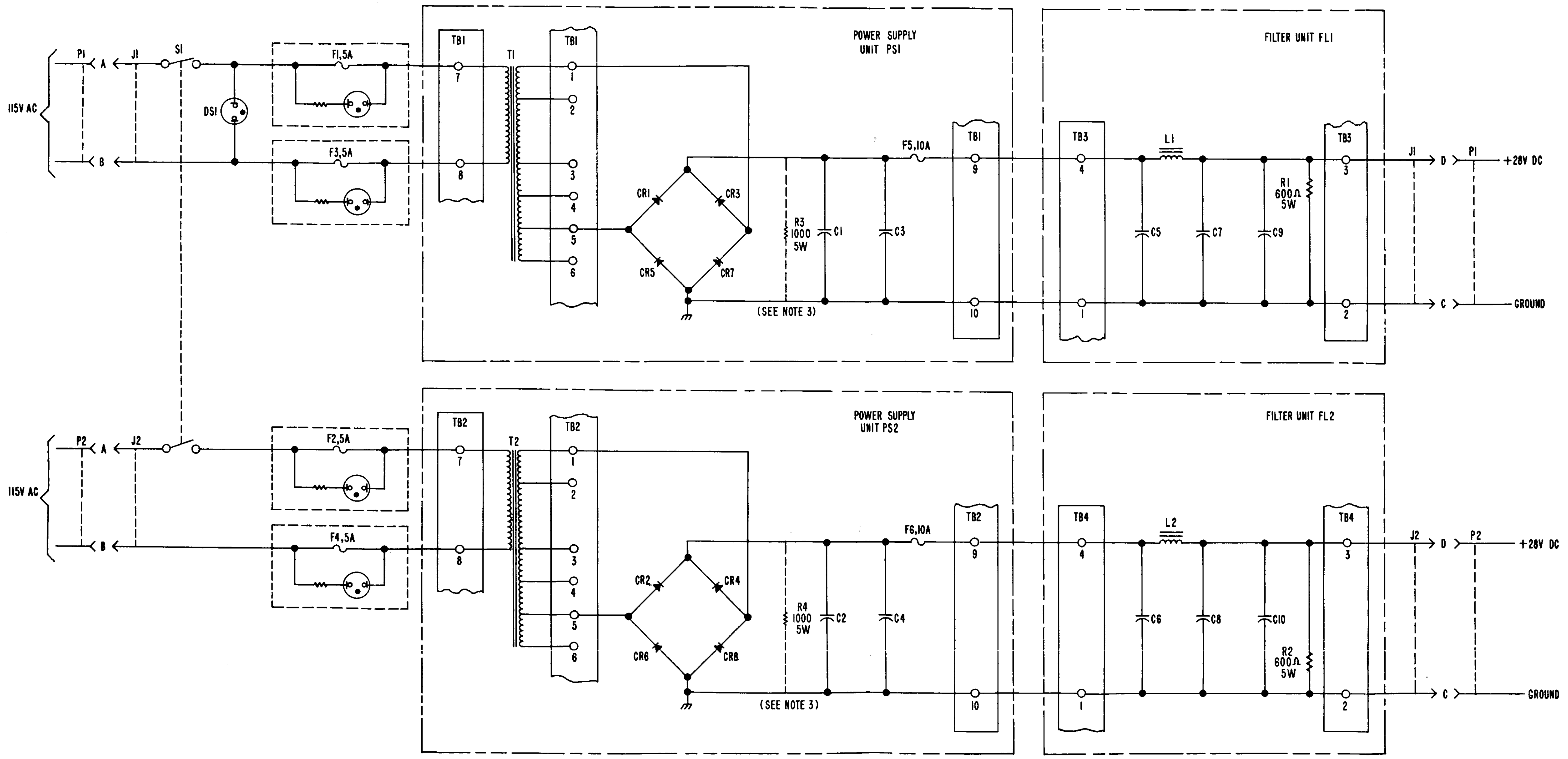



NOTES:
1. SYNCHRO REFERENCE TRANSFORMER LOCATED IN CENTER OF BACK OF CABINET.
2. ADD 6000 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT EXCEPT AUDIO AMPLIFIER.
3. ALL WIRES BREAKING OUT OF CABLES TO BE ONE INCH LONGER THAN NECESSARY WITH EXCESS WIRE DRESSED IN A NEAT LOOP ADJACENT TO TERMINALS.
4. UNLESS OTHERWIRE SPECIFIED ALL WIRES ARE WHITE AND ARE NO. 18.
5. —⊖— INDICATES SHIELDED WIRE (ITEM 18)
6. SECTION REFERENCE DESIGNATIONS OF SWITCHES ARE AS FOLLOWS.




7. USE CABLE CLAMP NO. MS3057-12 WITH CONNECTOR NO. MS3106R-20-7P.
USE CABLE CLAMP NO. MS3057-10 WITH CONNECTOR NO. MS3106R-18-12P.
USE CABLE CLAMP NO. MS3057-6 WITH CONNECTOR NO. MS3106R-20-7P

Figure 7-2. Acquisition Data Console, Physical Wiring Diagram




NOTES:
1. ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.
2. ALL CAPACITORS ARE 4000 UF 50VDC.
3. BLEEDER RESISTORS R3 AND R4 NOT USED ON SOME MODELS.

Figure 7-3. **Dual Power Supply, Schematic Diagram**

NOTE:
ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.

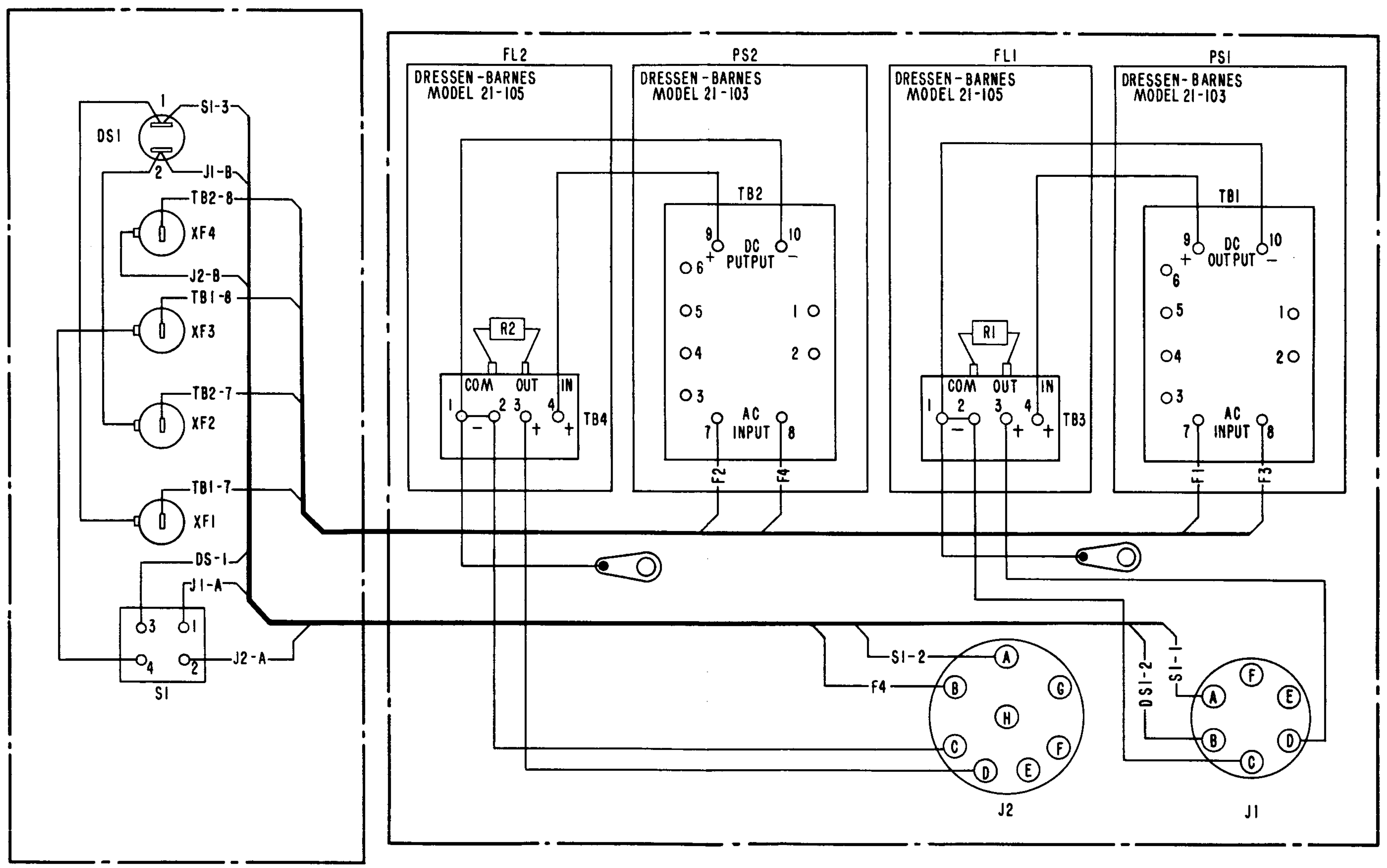
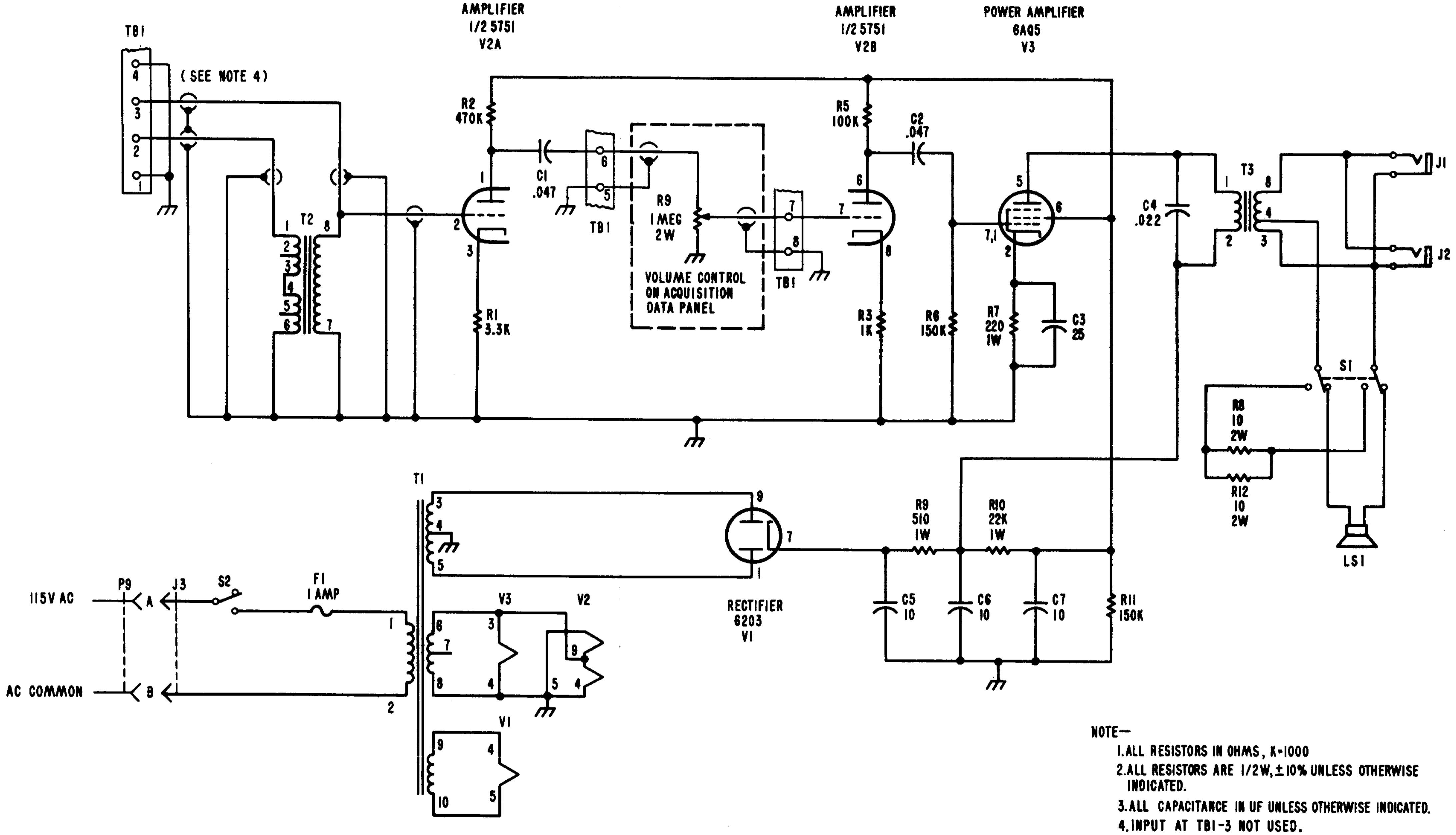



Figure 7-4. Dual Power Supply, Physical Wiring Diagram




NOTE—
1. ALL RESISTORS IN OHMS, K=1000
2. ALL RESISTORS ARE 1/2W, ±10% UNLESS OTHERWISE INDICATED.
3. ALL CAPACITANCE IN UF UNLESS OTHERWISE INDICATED.
4. INPUT AT TB1-3 NOT USED.

Figure 7-5. Audio Amplifier, Schematic Diagram

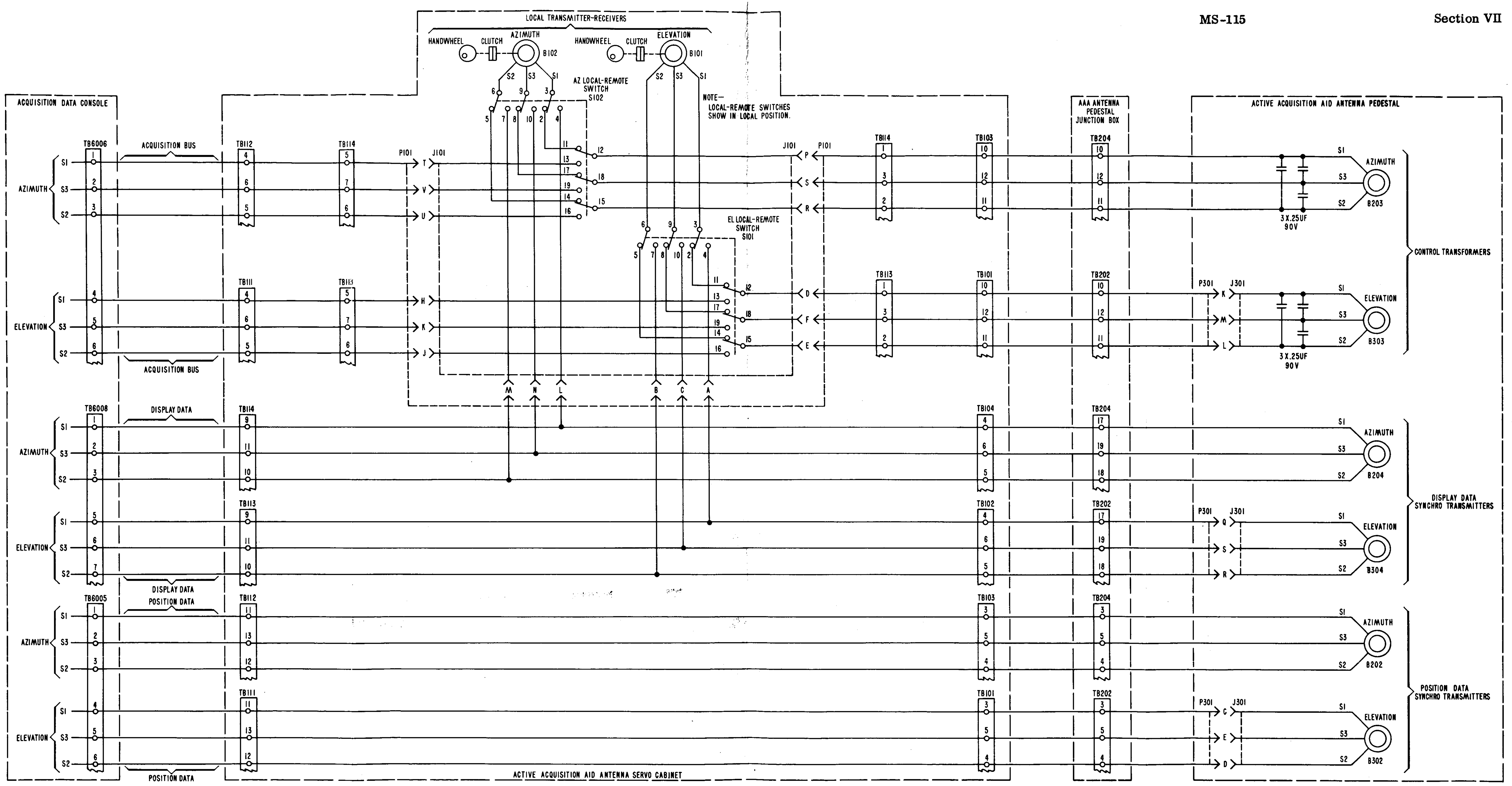



Figure 7-6. Synchro Stator Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram

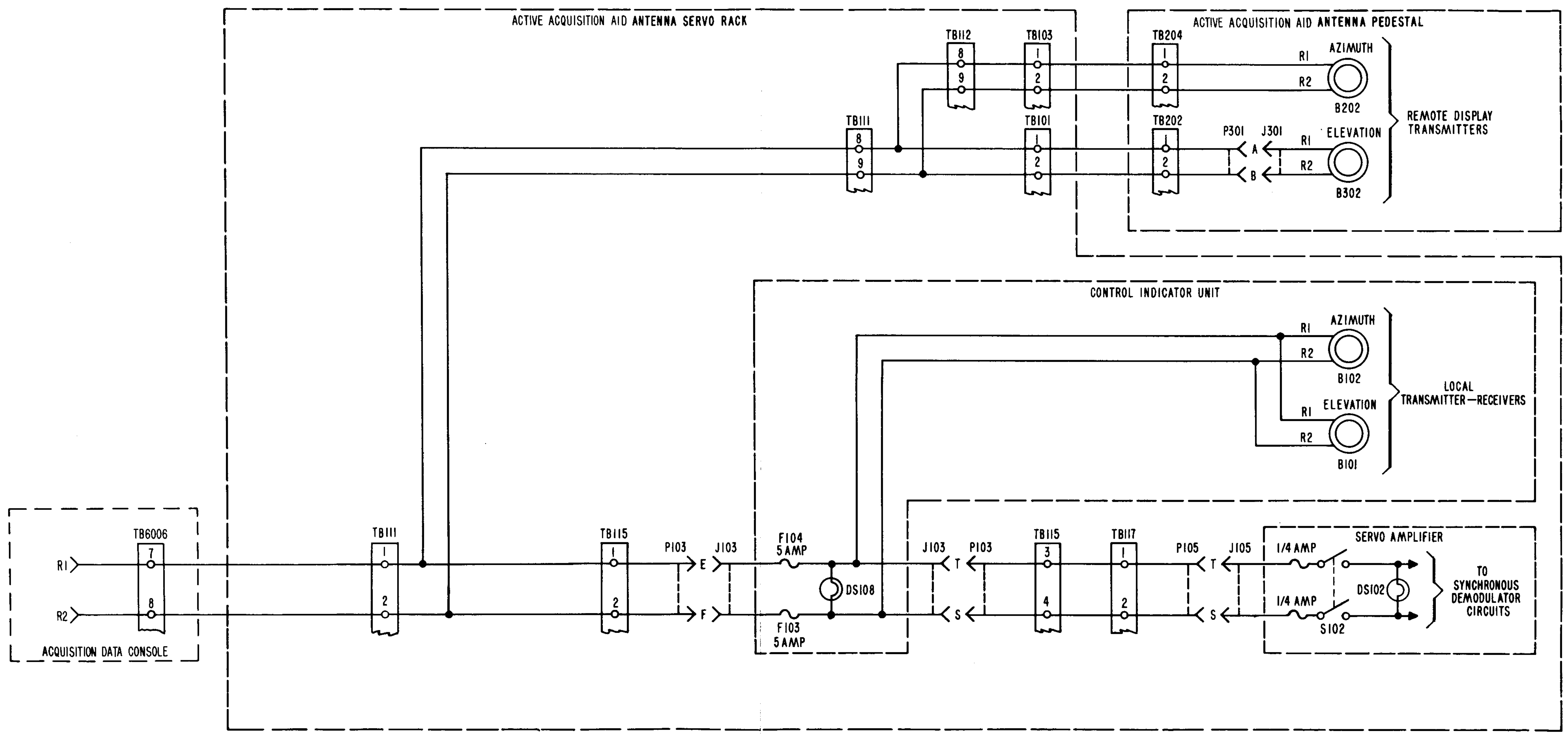



Figure 7-7. Synchro Reference Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram

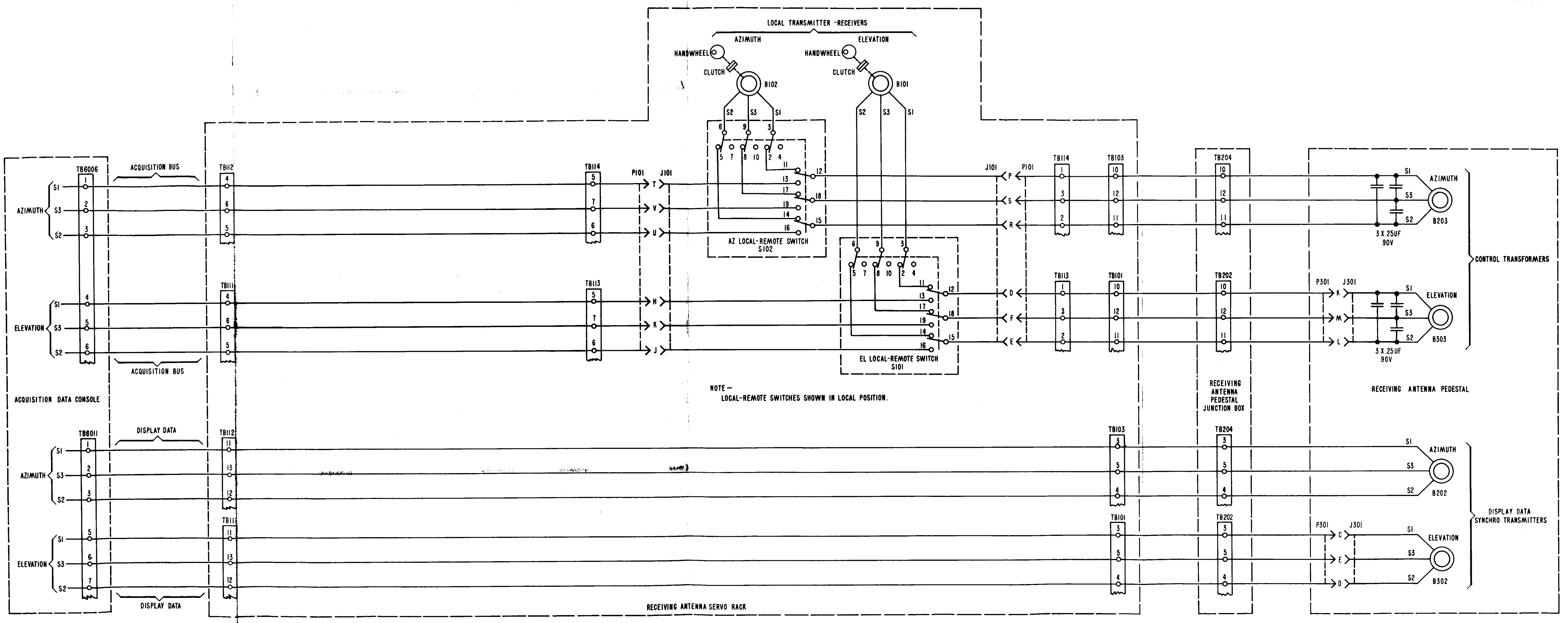



Figure 7-8. Synchro Stator Circuit Connections between Receiving Antenna and Acquisition Data Console, Schematic Diagram

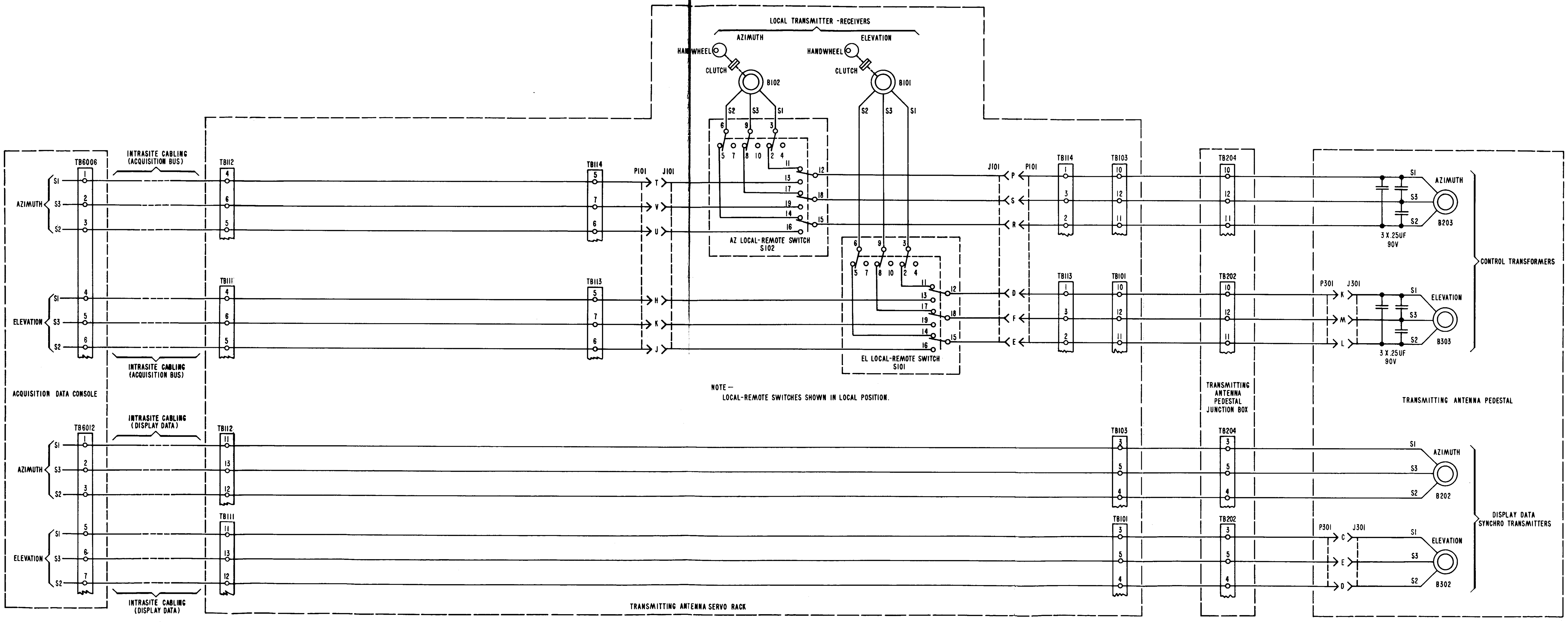



Figure 7-9. Synchro Stator Circuit Connections between Transmitting Antenna and Acquisition Data Console, Schematic Diagram

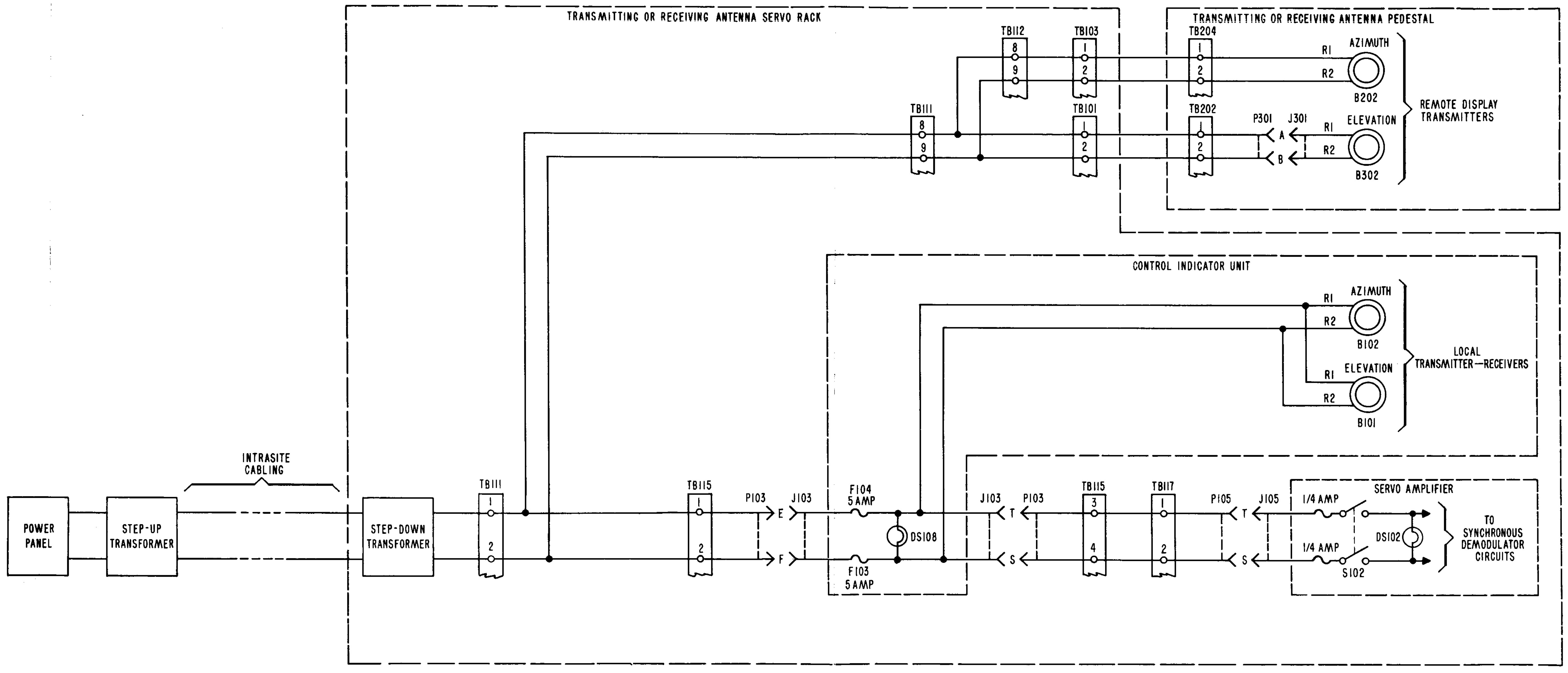



Figure 7-10. Synchro Reference Circuit Connections between Receiving or Transmitting Antenna and Site Power Panel, Schematic Diagram

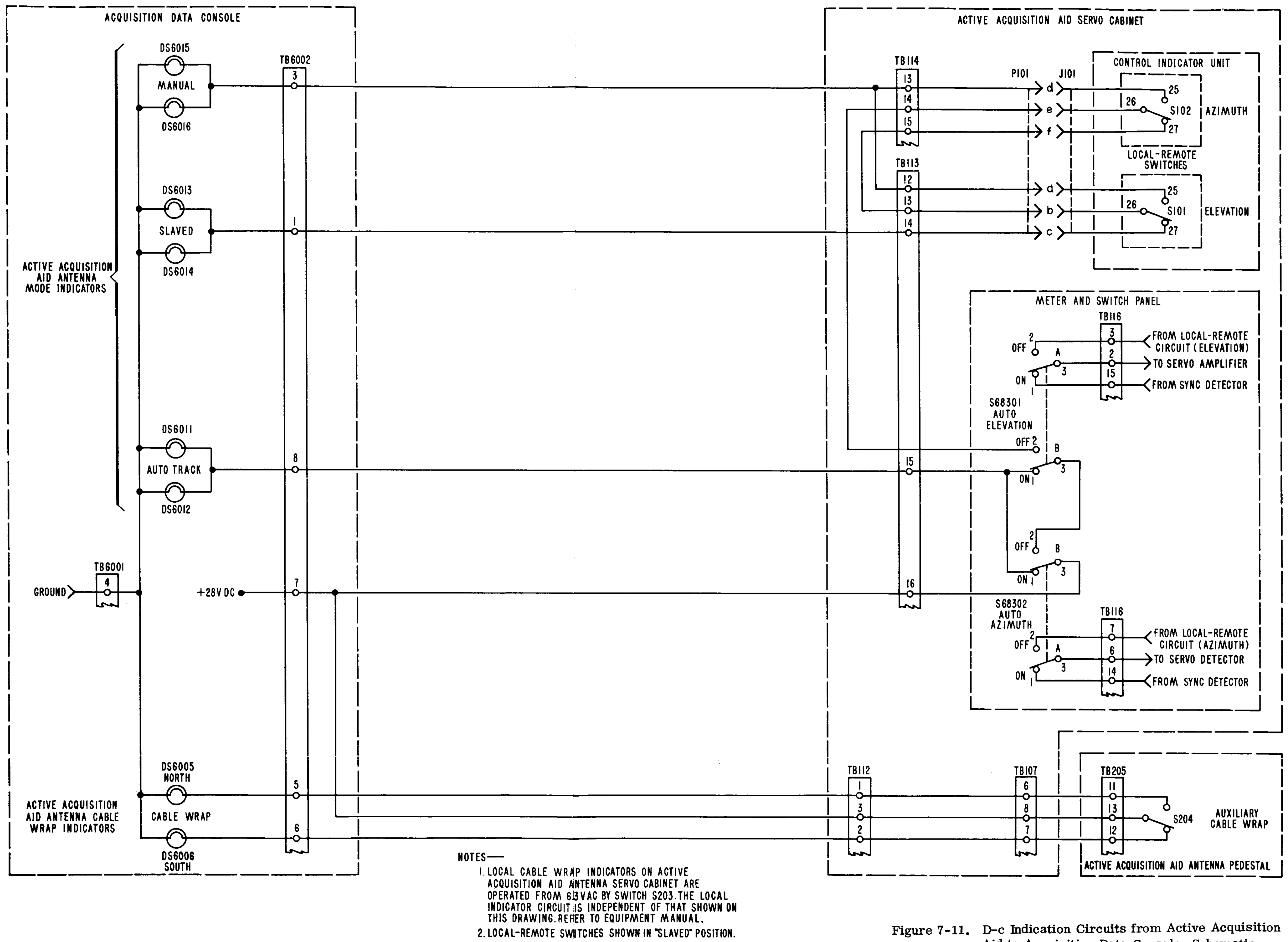
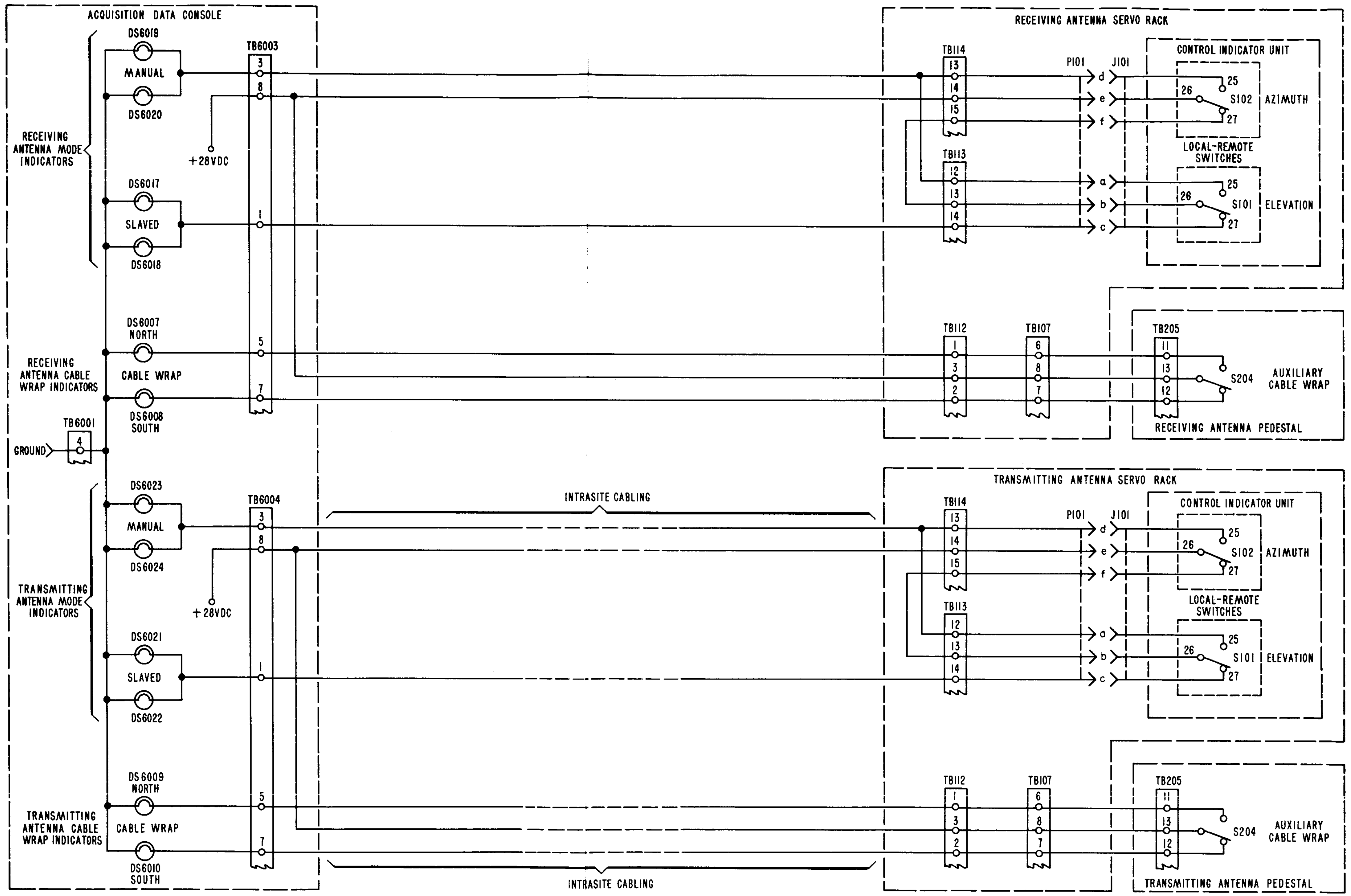


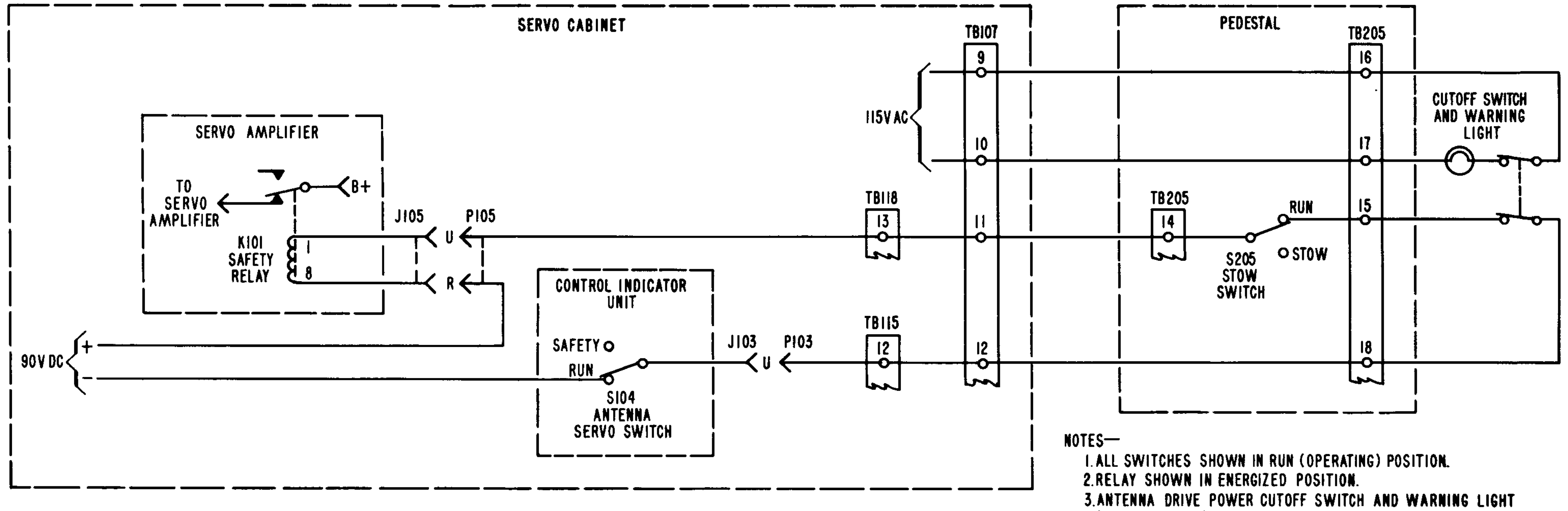

Figure 7-11. D-c Indication Circuits from Active Acquisition Aid to Acquisition Data Console, Schematic Diagram




NOTES—

1. LOCAL CABLE WRAP INDICATORS ON TRANSMITTING AND RECEIVING ANTENNA SERVO RACK ARE OPERATED FROM 6.3 VAC BY SWITCH S203. THE LOCAL INDICATOR CIRCUIT IS INDEPENDENT OF THAT SHOWN ON THIS DRAWING. REFER TO EQUIPMENT MANUAL.
2. LOCAL-REMOTE SWITCHES SHOWN IN "SLAVED" POSITION.

Figure 7-12. D-c Indication Circuits from Receiving and Transmitting Antennas to Acquisition Data Console, Schematic Diagram




NOTES—
1. ALL SWITCHES SHOWN IN RUN (OPERATING) POSITION.
2. RELAY SHOWN IN ENERGIZED POSITION.
3. ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (ONE ASSEMBLY) ARE MOUNTED NEAR TOP OF LADDER LEADING TO ANTENNA PLATFORM.

Figure 7-13. Active Acquisition Aid Antenna Safety Circuit, Schematic Diagram

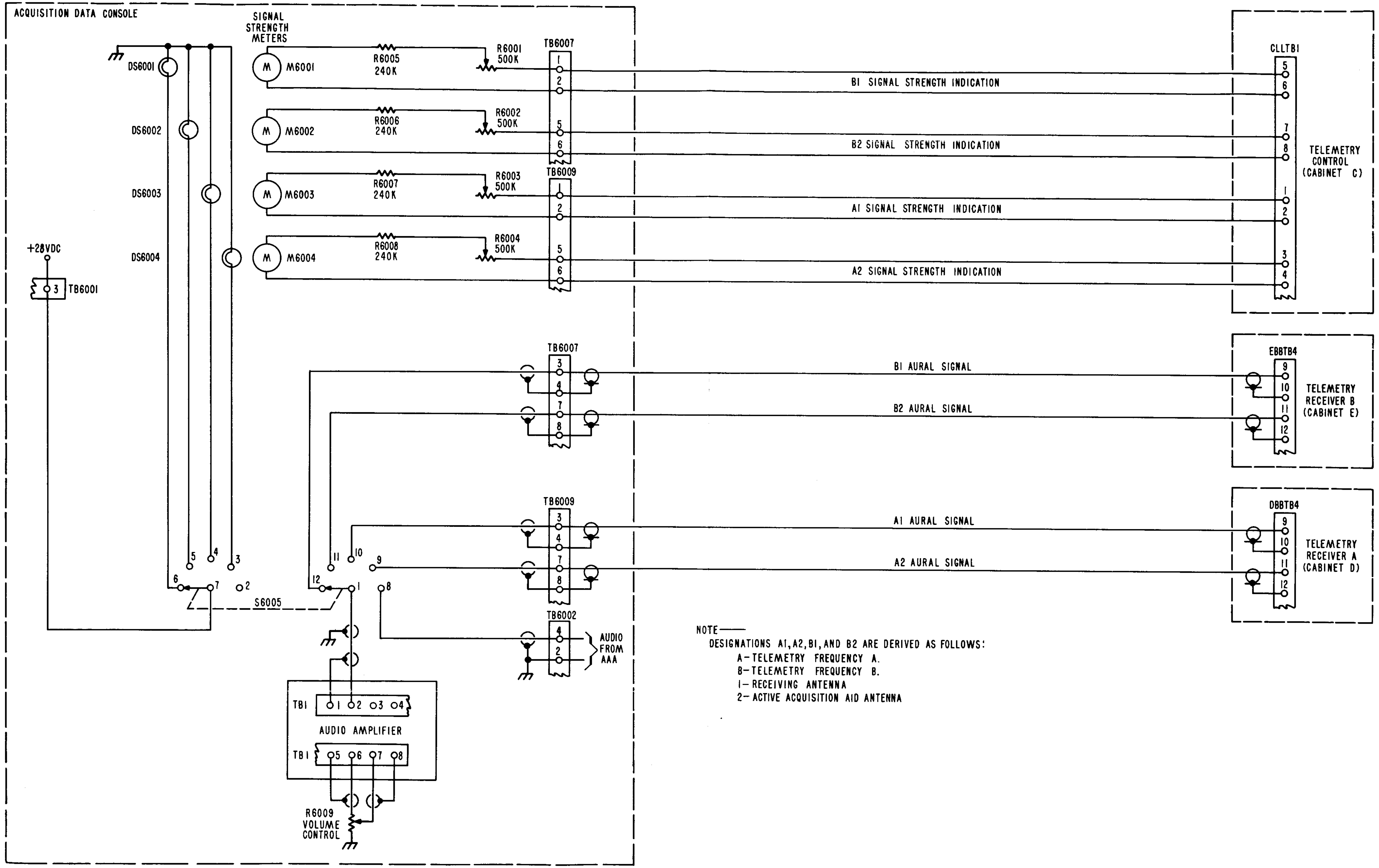
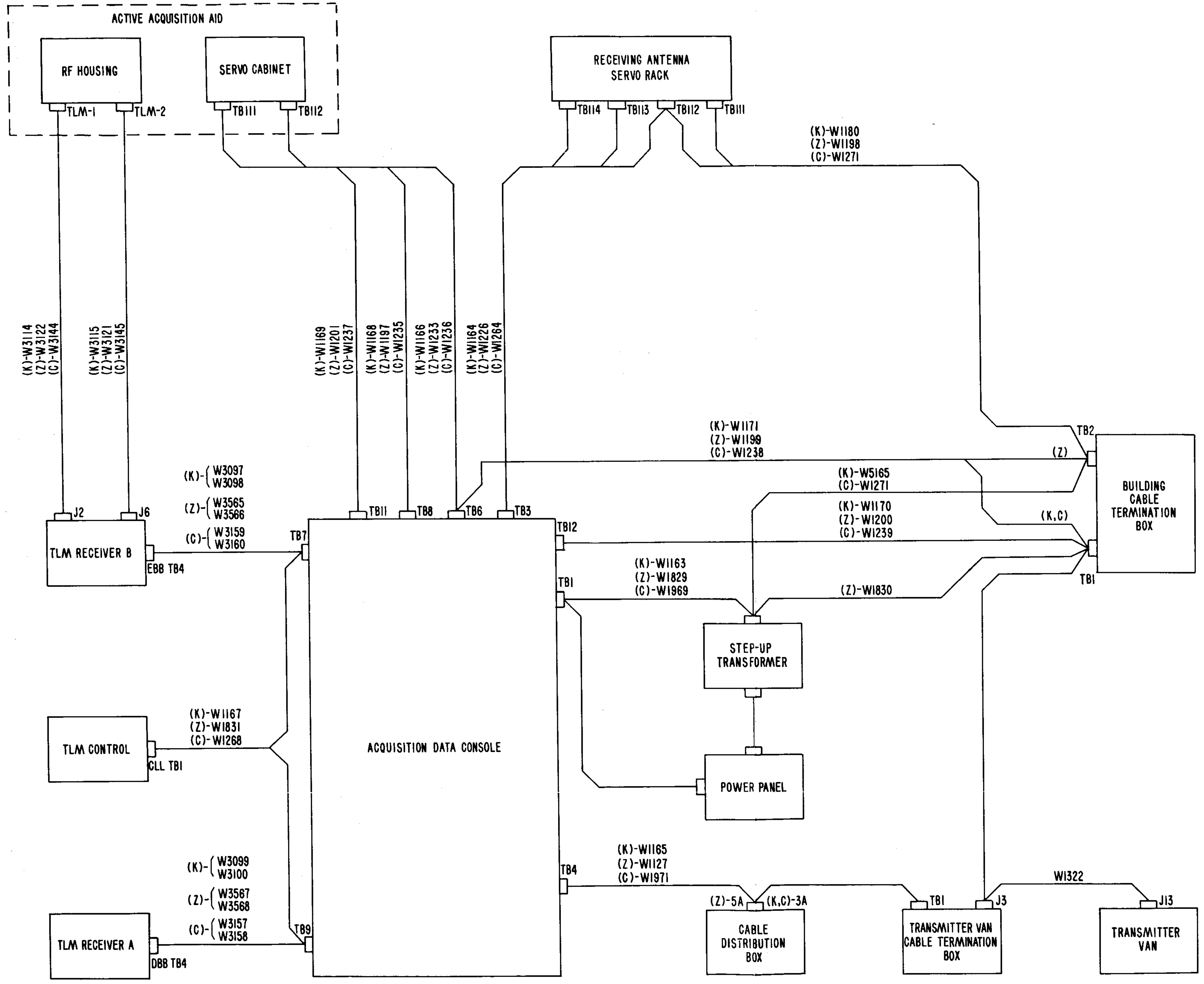



Figure 7-14. Signal Strength Indication and Audio Monitor Circuits, Schematic Diagram




NOTE:
1-LETTER PRECEDING TERMINALS AND CABLE NUMBERS DESIGNATES THE FOLLOWING SITES:
(K)-KANO, NIGERIA,
(Z)-ZANZIBAR,
(C)-CANTON ISLAND.
2-TERMINALS AND CABLE NUMBERS PRECEDED BY LETTER APPLICABLE TO SITE DESIGNATED IN NOTE 1.
3-TERMINALS AND CABLE NUMBERS NOT PRECEDED BY LETTER APPLICABLE TO EACH SITE.

Figure 7-15. Acquisition System Interconnecting Cabling Diagram, Kano, Nigeria, Zanzibar, and Canton Island